U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-286 724

Nevada Particulate Control Study for Air Quality Maintenance Areas Reno and Las Vegas Urban Areas

PEDCo-Environmental, Inc, Cincinnati, OH

Prepared for

Environmental Protection Agency, San Francisco, CA Air and Hazardous Materials Div

Mar 77

PB 286 724

EPA-909/9-77-001
March 1977

NEVADA PARTICULATE CONTROL STUDY FOR AIR QUALITY MAINTENANCE AREAS

RENO AND LAS VEGAS
URBAN AREAS

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region IX
Air and Hazardous Materials Division
San Francisco, California 94111

513

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-909/9-77-001

2.

3. RECIPIENT'S ACCESSION NO.

4. TITLE AND SUBTITLE
Nevada Particulate Control Study
For Air Quality Maintenance Areas

5. REPORT DATE March 1977

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
George A. Jutze, John M. Zoller, Kenneth Axetell, and Robert Livingston

8. PERFORMING ORGANIZATION REPORT NO. 3155-CC

9. PERFORMING ORGANIZATION NAME AND ADDRESS
PEDCo Environmental, Inc.
Chester Towers, 11499 Chester Road
Cincinnati, Ohio 45246

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO. 68-02-1375, Task 29

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Air and Hazardous Materials Division, Region IX
100 California Street
San Francisco, California 94111

13. TYPE OF REPORT AND PERIOD COVERED Final

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the Nevada Department of Human Resources and the District Health Departments of Clark and Washoe Counties, Nevada

16. ABSTRACT

To evaluate the non-attainment of total suspended particulate (TSP) standards in the Clark-Mohave-Yuma (Las Vegas) and Northwest Nevada Intrastate (Reno) Air Quality Control Regions (AQCR's), six Task Reports were prepared. The Task A, B, and C Reports identified and quantified the major contributing sources. Strategies to control these sources were presented in the Task D/E Reports. A weighing factor was developed in Task F to account for the disparity between mineral emissions and mineral loadings on high-volume sampler filters. The control strategies were then evaluated using the Hanna-Gifford diffusion model. Results showed that the TSP standards can be met in the Reno AQCR with adoption of the proposed street cleaning program, while the TSP standards will be exceeded in the Las Vegas AQCR even with adoption of the proposed strategies.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Control Strategy Emission Inventory	13B
Dust	Fugitive Dust Total Suspended Particulates (TSP's)	11G
Monitors	Sampling/Measurement	14G

18. DISTRIBUTION STATEMENT Unlimited

19. SECURITY CLASS (This Report) Unclassified

20. SECURITY CLASS (This page) Unclassified

21. NO. OF PAGES 531

22. PRICE PCA23/MF A01

EPA Form 2220-1 (9-73)

EPA-909/9-77-001

NEVADA PARTICULATE CONTROL STUDY FOR AIR QUALITY MAINTENANCE AREAS

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Contract No. 68-02-1375
Task Order No. 29

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Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Air and Hazardous Materials Division
Region IX
San Francisco, California 94111

March 1977

1a

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This report was furnished to the Environmental Protection Agency by PEDCo Environmental, Inc., 11499 Chester Road, Cincinnati, Ohio 45246, in fulfillment of EPA Contract No. 68-02-1365, Task Order No. 29. This report has been reviewed by the Air and Hazardous Materials Division, EPA, Region IX and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Region IX Publication No. EPA 909/9-77-001

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ACKNOWLEDGMENT

Many individuals and organizations have been helpful in developing this report; for these contributions the project management extends its sincere gratitude.

The contributions of Messrs. Charles Breese and Brian Wright of the Washoe County District Health Department; Donald Arkell, Janette Smith, and Mike Naylor of the District Health Department of Clark County; Richard Serdoz of the Nevada Department of Human Resources; and Dallas Safriet of EPA's Monitoring Data and Analysis Division were of particular significance.

Mr. Morris Goldberg, Environmental Protection Agency, served as Project Officer, Mr. George A. Jutze, PEDCo Environmental, Inc., the Project Director, and Mr. John M. Zoller, the Project Manager, assisted by Messrs. Kenneth Axetell and Robert Livingston.

NEVADA PARTICULATE CONTROL STUDY
FOR AIR QUALITY MAINTENANCE AREAS

INTRODUCTION

BACKGROUND

At the present time the National Ambient Air Quality Standard (NAAQS) for Total Suspended Particulate (TSP) is being exceeded in the Clark-Mohave-Yuma (Las Vegas) and Northwest Nevada Intrastate (Reno) Air Quality Control Regions (AQCR). Since relatively few uncontrolled point sources and conventional area sources of TSP have been identified in these regions, the probability exists that the impact on TSP air quality from fugitive dust sources is causing non-attainment.

PURPOSE AND SCOPE

The purpose of this project was to:
(1) identify the sources impacting or projected to impact in the future on sampling sites and other receptor locations with high particulate concentrations;
(2) determine the relative contribution of each of the identified sources and source categories;
(3) recommend control strategies; and
(4) estimate the expected effectiveness of the recommended control strategies on emission reductions and on ambient air quality.

To accomplish these goals, six specific tasks were performed as described below:

A. Air Quality Monitoring Data

All necessary air quality and meteorological data in the study areas for the base year 1975 were assembled and analyzed to better identify the nature of the particulate problem. "Micro-inventories" of the areas surrounding each hi-vol location were also conducted to determine specific sources and source categories influencing the measurements at the sites.

B. Factors Influencing Emissions from Fugitive Sources

All fugitive dust and naturally occurring dust source categories were identified and available emission factors and data relative to variations in and particle size distribution of the emission rates were assembled. From these data, estimates of emission rates by particle size range for each fugitive dust source category were derived. Functions were developed to describe variations in these expected emission rates.

C. Emission Inventory and Emission Projections

An emission inventory of all point and area sources of particulate, including fugitive dust and background sources, was prepared for each study area. Emissions were accurately allocated into a grid system. The emission estimate subtotals in each category were provided by season and particle size range. Projected emission inventories for 1980 and 1985 were prepared in the same format as the base-year inventory.

D. Emission Modeling

A relationship between emissions and ambient air quality was derived for the study areas. The model was then used to calculate concentrations at each of the specified receptor sites for the base year and 1985.

E. Control Strategy Development

Potential control measures for significant source categories were reviewed. As a result, five control strategies were independently evaluated in the Las Vegas area and three strategies in the Reno area. The recommended strategies were tested by input of the estimated reduced emissions to the source-receptor model developed in Task D.

F. Particulate Characterization

An analysis of hi-vol glass fiber, hi-vol cellulose acetate, and Andersen glass fiber were compared with inventory results for each sampling site for determination of source contribution. The filters analyzed were both historical (hi-vol glass fiber) and the results of a four-week special sampling program (hi-vol glass fiber, cellulose acetate, and Andersen glass fiber). In addition, approximately fifteen particulate grab samples of soil, deposited dust, and the like were analyzed from each of the project study areas. Analysis included microscopic, silica fraction, combustible fraction, and two suspect metals (calcium and lead).

PROJECT REPORTS

A project report was prepared for each task and are entitled as follows:

- Task A Report - Air Quality Monitoring Data
- Task B Report - Factors Influencing Emissions from Fugitive Sources
- Task C Report - Emission Inventory and Emission Projections
- Task D/E Report - Emission Modeling and Control Strategy Development (Las Vegas)
- Task D/E Report - Emission Modeling and Control Strategy Development (Reno)
- Task F Report - Particulate Characterization Study

All of these reports are included as separate sections of this document.

TASK A REPORT
AIR QUALITY MONITORING DATA

1. INTRODUCTION

BACKGROUND

At the present time the National Ambient Air Quality Standard (NAAQS) for Total Suspended Particulate (TSP) is being exceeded in the Clark-Mohave-Yuma (Las Vegas) and Northwest Nevada Intrastate (Reno) Air Quality Control Regions (AQCR). Since relatively few uncontrolled point sources and conventional area sources of TSP have been identified in these regions, and the probability exists that the impact on TSP air quality from fugitive dust sources is causing non-attainment. Therefore, as part of a five-phase effort[1] to resolve this problem, PEDCo-Environmental has assembled and analyzed all available air quality and meteorological data for the base year 1975 in the study areas to better identify the nature of the particulate problem. "Microinventories" of the areas surrounding each sampling location were also conducted to determine specific sources and source categories influencing the measurements at the sites.

Geographically, the Las Vegas study area includes Clark County in the southernmost part of Nevada. It is situated in the Las Vegas Valley, the southwestern part of the Great Basin. Most of the area is sloping lowlands between 1800 and 2200 feet above sea level. Frenchman Mountain, located in the eastern part of the study area, rises to an elevation of 4000 feet. The climate is characterized by low humidity, abundant sunshine, mild winters and hot dry summers. En-

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compassed by the study area are the cities of Las Vegas, North Las Vegas and Henderson. Nellis Air Force Base located northeast of Las Vegas is also included. In 1970 50 percent of Nevada's population lived within this area. The most important industry is that of furnishing services and entertainment to the tourists. There is, however, a considerable amount of non-tourist related commercial and industrial activities. Agriculture is carried out on a small scale.

The Reno study area is located in southern Washoe County in the west-central part of Nevada adjoining the State of California. This area, which encompasses the cities of Reno and Sparks, is situated on the eastern slope of the Sierra Nevada Mountains and lies in a large valley known as the Truckee Meadows. At an average elevation of 4500 feet the climatic conditions are somewhat cooler and more humid than that found in the Las Vegas area. A combined population of over 97,000 people gives Reno/Sparks the second highest population in Nevada. Tourism is one of the main economic activities of this resort area. Business related to agriculture and mining is also of great importance.

AIR QUALITY

In the Las Vegas study area, TSP measurements at twelve sites have been collected for evaluation and analyses. Appendix A presents the raw data tabulation for the period of investigation for both the Las Vegas and Reno networks. Figure 1.1 shows the location of each site keyed to its name as specified by the Clark County Air Pollution Control Division which maintains and operates the air quality net-

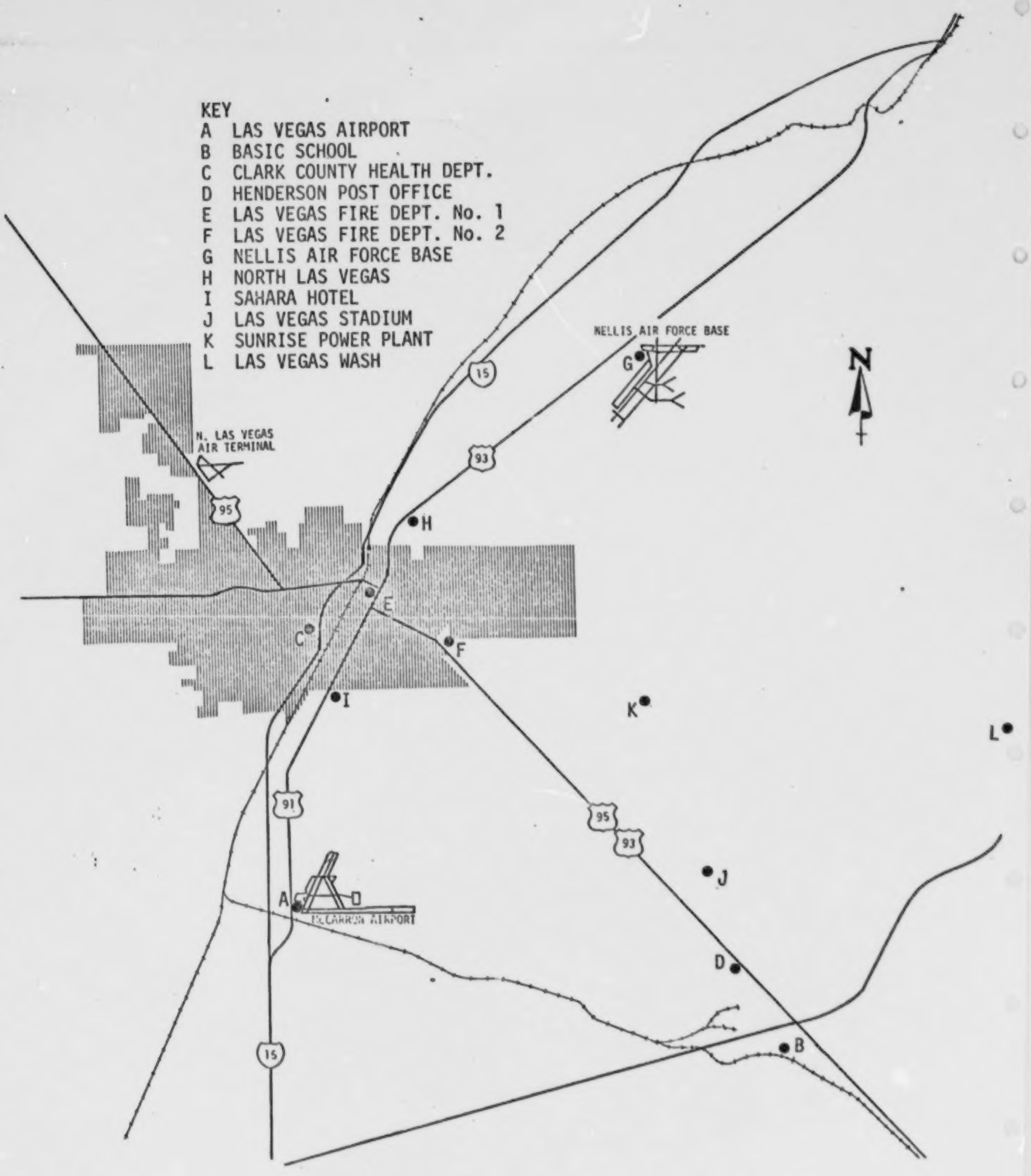

KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. No. 1
F LAS VEGAS FIRE DEPT. No. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
NELLIS AIR FORCE BASE
N
15
93
N. LAS VEGAS AIR TERMINAL
95
H
E
C
F
I
K
L
91
95
93
J
A
McCARRAN AIRPORT
D
B
15

Figure 1.1. The Clark County APCD sampling network for TSP.

work. A summary of agency data for the period October 1974 to October 1975 is presented in Table 1.1. Examination of these data reveals the scope and general magnitude of the current non-attainment situation.

TSP measurement data has also been obtained for twelve (12) sites in the Reno study area. Monitoring locations, keyed to the nomenclature derived by Washoe County Division of Environmental Protection, are located in Figure 1.2. A summary of agency data for the period October 1974 to October 1975 is presented in Table 1.2. The nature of the TSP situation in this region may also be generally defined upon inspection of these data.

METEOROLOGY

Summaries of the general meteorological conditions which prevailed in the two study areas during the period comparable to the TSP measurement interval being examined are presented in Tables 1.3 and 1.4 for Las Vegas and Reno respectively. The variance in parameters such as temperature and precipitation are readily apparent. Additionally, Figures 1.3 and 1.4 graphically demonstrate the distribution of wind directions in both regions during the twelve month period of interest. At Las Vegas, the strong south through west influence is easily observed, while in Reno a more general directional distribution about the strong westerly influence is noted.

APPROACH

In the following sections of this report we have:

Table 1.1. AIR QUALITY DATA SUMMARY FOR LAS VEGAS - TOTAL SUSPENDED PARTICULATES, 10/74 - 10/75

Site	Number of samples	Highest reading, date	Second highest reading, date	Third highest reading, date	Lowest reading, date	Annual geometric mean 10/74-10/75
Airport	61	883 (6-17-75)	161 (1-24-75)	140 (10-2-74)	31 (4-12-75)	69
Basic Jr. High	57	545 (6-17-75)	142 (1-24-75)	132 (5-12-75)	16 (4-6-75)	64
Clark Co. Health Department	54	778 (6-17-75)	247 (3-25-75)	187 (1-24-75)	31 (12-31-74)	91
Henderson P.O.	58	690 (6-17-75)	267 (10-2-74)	231 (3-25-75)	40 (4-6-75)	92
Las Vegas F.D. No. 1	58	451 (6-17-75)	188 (1-24-75)	177 (7-23-75)	28 (4-6-75)	82
Las Vegas F.D. No. 2	60	830 (6-17-75)	227 (1-24-75)	218 (11-13-74)	28 (12-31-74)	105
Nellis A.F.B.	51	672 (6-17-75)	129 (4-24-75)	122 (3-25-75)	12 (9-15-75)	51
North Las Vegas	56	788 (6-17-75)	273 (8-4-75)	240 (7-29-75)	39 (4-6-75)	105
Sahara Hotel	56	1129 (6-17-75)	895 (4-24-75)	376 (3-31-75)	29 (1-12-75)	117
Stadium	53	868 (6-17-75)	192 (10-2-74)	171 (5-30-75)	19 (4-6-75)	64
Sunrise Power Plant	58	793 (1-12-75)	569 (6-17-75)	207 (1-24-75)	22 (4-6-75)	92
Las Vegas Wash	41	138 (5-30-75)	131 (6-17-75)	96 (10-2-74)	5 (10-8-74)	32

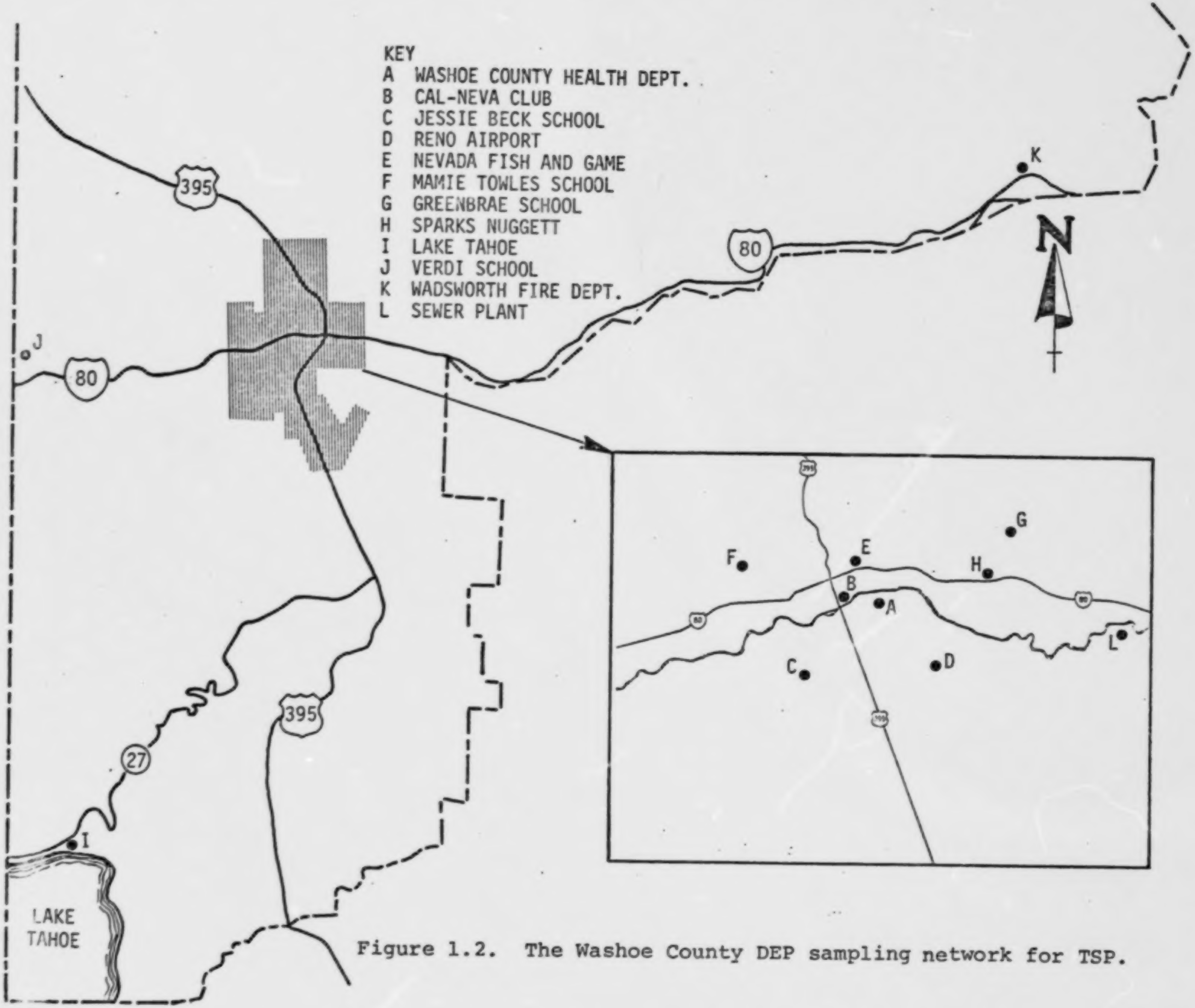

KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE
J VERDI SCHOOL
K WADSWORTH FIRE DEPT.
L SEWER PLANT
N
395
80
27
LAKE TAHOE
J
K
I
A
B
C
D
E
F
G
H
L

Figure 1.2. The Washoe County DEP sampling network for TSP.

Table 1.2. AIR QUALITY DATA SUMMARY FOR RENO - TOTAL SUSPENDED PARTICULATES, 10/74 - 10/75

Site	Number of samples	Highest reading, date	Second highest reading, date	Lowest reading, date	Annual geometric mean 10/74-10/75
Health Department	59	234 (1-24-75)	204 (12-19-74)	23 (1-6-75)	77
Cal-Neva Club	61	202 (2-11-75)	162 (12-19-74)	21 (9-15-75)	74
Jessie Beck School	55	103 (10-2-74)	96 (12-19-74)	15 (1-6-75)	44
Reno Airport	60	200 (6-17-75)	181 (10-20-74)	21 (1-6-75)	65
Nevada Fish & Game	61	189 (11-13-74)	153 (10-20-74)	21 (1-6-75)	57
Mamie Towles School	30[a]	50 (5-30-75)	49 (6-11-75)	13 (8-28-75)	32
Greenbrae School	61	366 (10-20-74)	187 (10-26-74)	17 (11-1-74)	58
Sparks Nugget	60	298 (3-1-75)	206 (1-24-75)	32 (11-1-74)	90
Lake Tahoe	61	113 (7-29-75)	76 (10-2-74)	2 (1-6-75)	22
Verdi School	60	54 (10-2-74)	51 (5-12-75)	3 (3-7-75)	18
Wadsworth F.D.	59	364 (3-25-75)	168 (6-17-75)	11 (4-12-75)	46
Sewer Plant	57	120 (8-4-75)	114 (7-11-75)	12 (11-1-74)	50

[a] Data for April 6, 1975 through September 27, 1975.

Table 1.3. GENERAL METEOROLOGICAL CONDITIONS FOR LAS VEGAS - 10/74 - 10/75

Month	Average temperature °F	Total precipitation		Wind		Average relative humidity, %	Barometric pressure, in. Hg.
		Rain or water equivalent, in.	Snow or ice in.	Resultant direction	Average speed mph		
October, 1974	69.3	0.61	0	WSW	8.0	36.3	27.73
November, 1974	54.8	0.23	0	W	7.6	40.6	27.81
December, 1974	44.4	0.59	T	NNW	7.9	42.9	27.86
January, 1975	45.3	0.01	0	WNW	8.9	32.5	27.84
February, 1975	48.8	0.05	T	W	9.6	32.1	27.77
March, 1975	53.9	1.07	T	W	13.0	34.5	27.64
April, 1975	56.6	0.42	0	SW	12.1	32.5	27.62
May, 1975	58.7	0.35	0	W	9.2	21.0	27.59
June, 1975	83.8	T	0	SW	10.1	14.1	27.56
July, 1975	90.3	0.26	0	SSW	9.4	21.9	27.60
August, 1975	87.5	0.06	0	SW	10.5	15.6	27.64
September, 1975	81.7	1.17	0	SW	7.9	24.5	27.69
Yearly	64.6	4.82	T		9.5	43.6	27.70

Table 1.4. GENERAL METEOROLOGICAL CONDITIONS FOR RENO - 10/74 - 10/75

Month	Average temperature °F	Total precipitation		Wind		Average relative humidity, %	Average Barometric pressure, in. Hg.
		Rain or water equivalent, in.	Snow or ice in.	Resultant direction	Average speed, mph		
October, 1974	49.3	0.69	0	NNW	4.7	54.4	25.64
November, 1974	40.4	0.27	0	SW	4.2	63.1	25.65
December, 1974	31.1	0.56	4.0	WNW	3.9	71.5	25.68
January, 1975	32.3	0.32	2.7	WSW	4.4	69.5	25.66
February, 1975	34.1	1.74	19.0	SSW	7.4	67.0	25.57
March, 1975	38.4	1.59	12.1	SW	8.5	59.5	25.46
April, 1975	39.9	0.62	4.8	W	7.9	54.3	25.48
May, 1975	54.2	0.21	2.2	WNW	8.0	41.4	25.54
June, 1975	62.4	0.21	T	W	8.5	39.0	25.55
July, 1975	70.4	0.03	0	W	7.6	37.9	25.56
August, 1975	64.8	1.03	0	W	6.2	44.0	25.60
September, 1975	64.2	0.92	0	WNW	4.0	47.9	25.64
Yearly	48.5	8.19	44.8		6.3	54.1	25.59

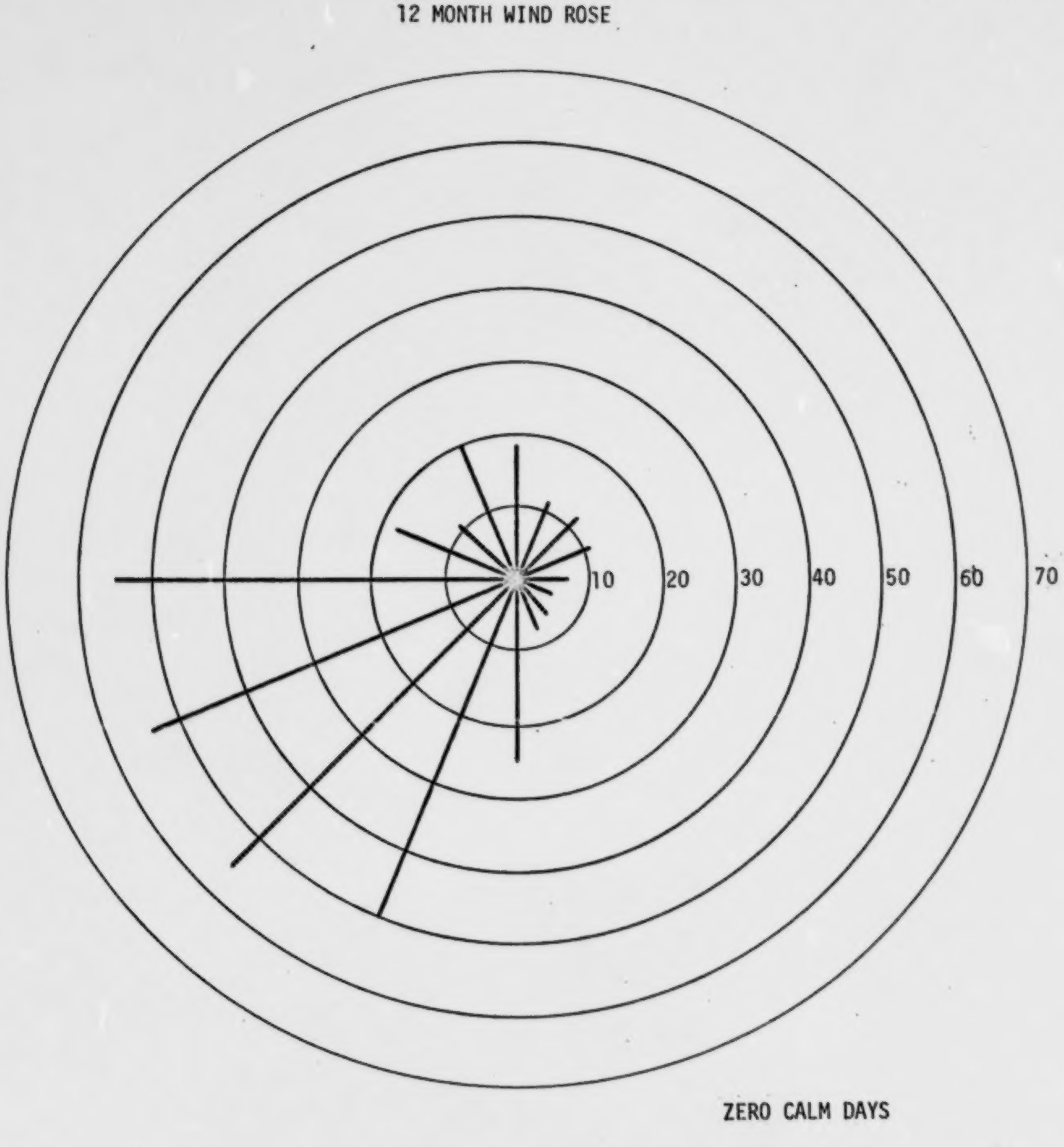


Figure 1.3. Wind direction distribution at Las Vegas Airport, 10/74 - 10/75.

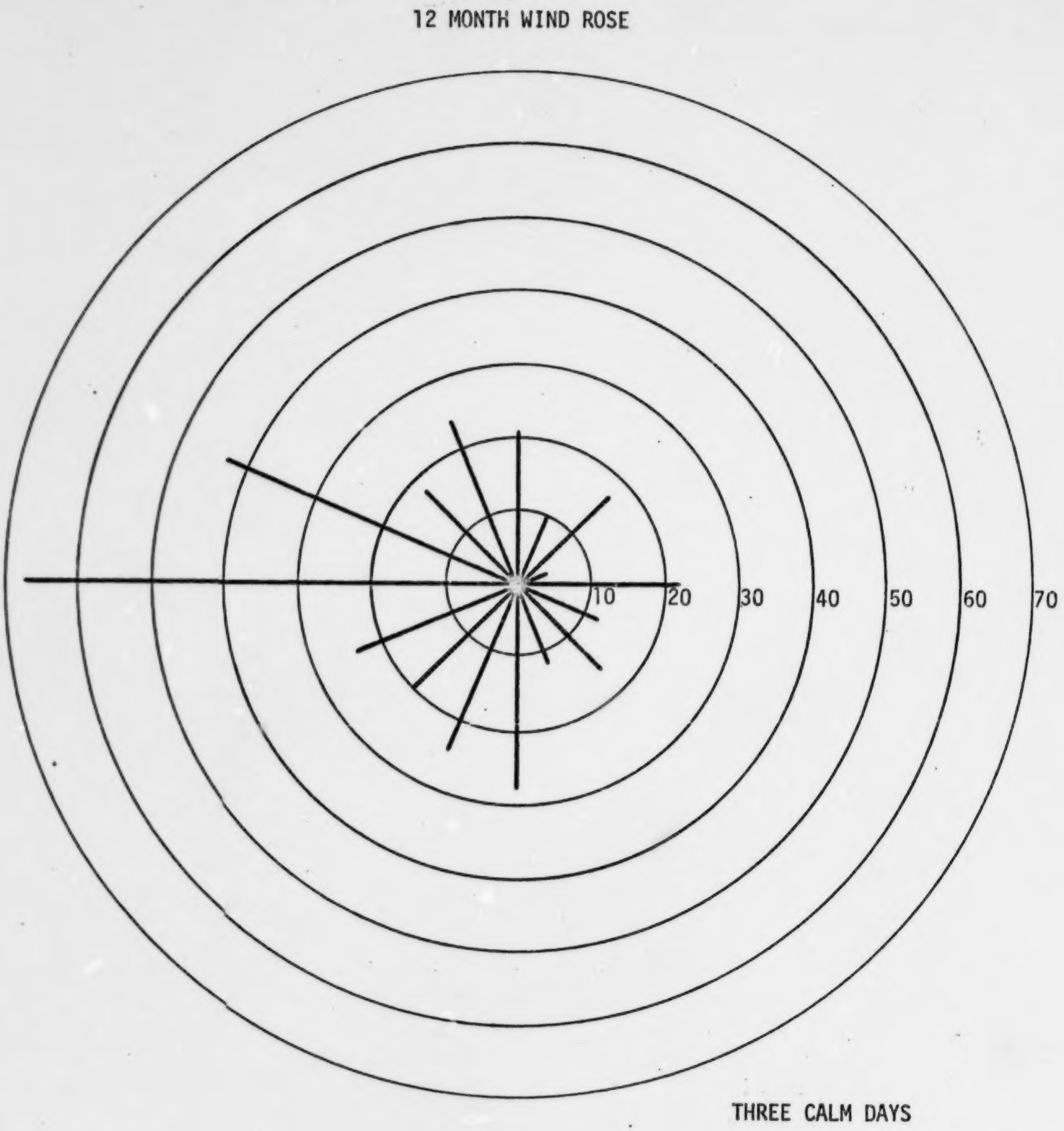


Figure 1.4. Wind direction distribution at Reno Airport, 10/74 - 10/75.

- Evaluated the general characteristics of the TSP air quality in both regions relative to seasonal fluctuations, correlation of extreme values, influence of meteorology, and the like.
- Developed "microinventories" of all sources of TSP which may create a substantial impact on the measurements at each individual site.
- Evaluated each sampling site exposure relative to influences which might bias the sampling.
- Investigated the relationship between emission density and measured air quality and evaluated extreme values in light of possible source impacts.
- Presented a series of conclusions based on our judgement relative to analysis of all information available.

2. GENERAL CHARACTERISTICS OF PARTICULATE AIR QUALITY

Pollution roses, frequency distributions, and seasonal trends were investigated in order to characterize the ambient particulate air quality data. Additionally, particle size data will be analyzed when it becomes available.

POLLUTION ROSES

Pollution roses were prepared for the hi-vol sites in both study areas and are presented in Figures 2.1 and 2.2. Shown are the number of days the particulate National Ambient Air Quality Standard (NAAQS) of 75 $\mu g/m^3$ was exceeded in each wind direction. The wind direction was recorded at the municipal airports and assumed to be valid for most sites. Pollution roses were not constructed for the Las Vegas Wash, Lake Tahoe, Verdi School, and Wadsworth sites because their distance from the airport made wind data unreliable. Note that the "spikes" on the pollution roses point into the wind.

The pollution roses for Las Vegas are presented in Figure 2.1. The number of days the standard was exceeded and the total number of samples are shown for each site. At Las Vegas Wash (not presented), 4 of 41 samples exceeded 75 $\mu g/m^3$.

To assist in interpreting the pollution roses, a wind rose was constructed for only the days when the hi-vol samplers were operated. This is also shown on Figure 2.1.

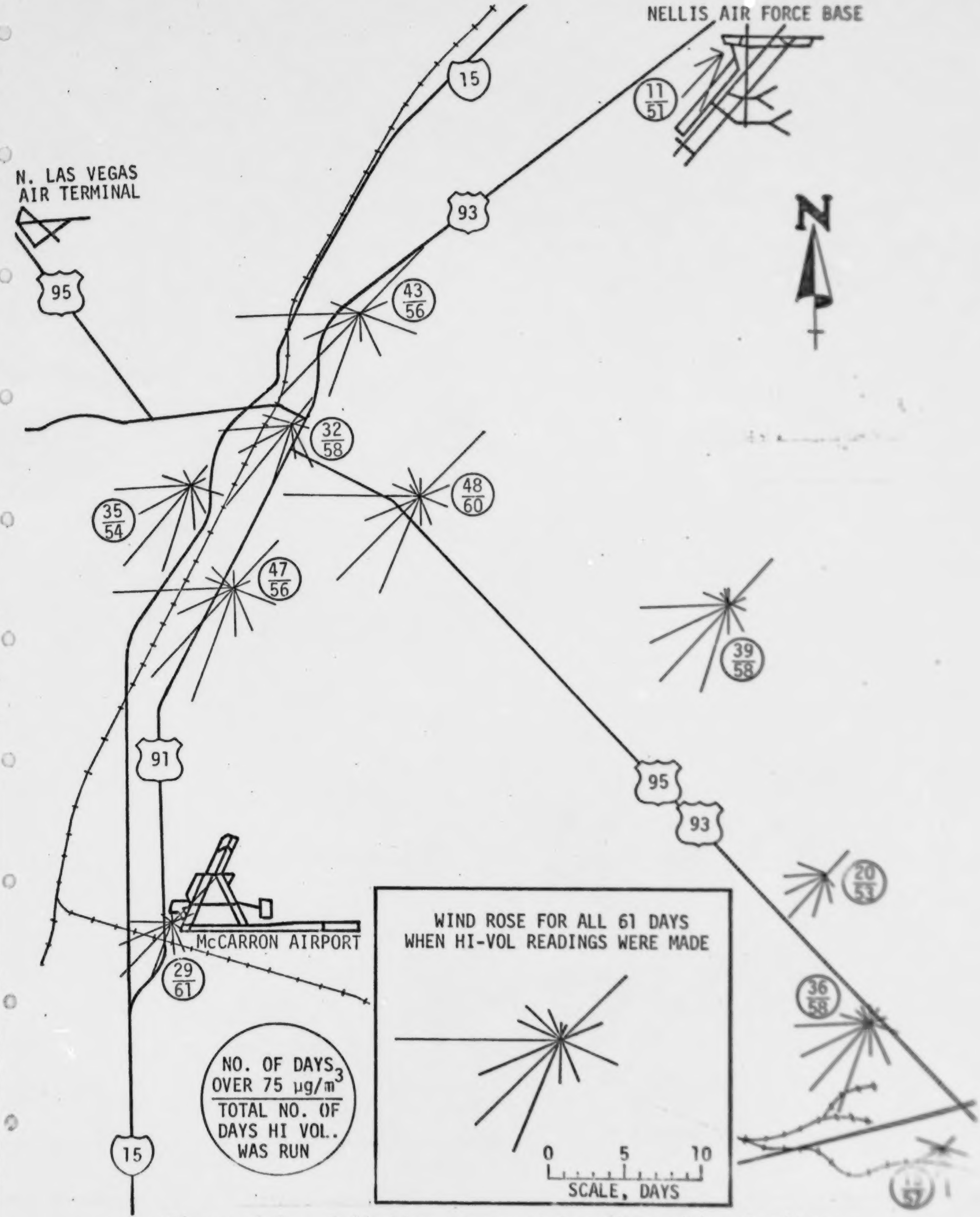

NELLIS AIR FORCE BASE
11/51
15
N. LAS VEGAS AIR TERMINAL
93
N
95
43/56
32/58
35/54
48/60
47/56
39/58
91
95
93
20/53
McCARRON AIRPORT
29/61
36/58
WIND ROSE FOR ALL 61 DAYS WHEN HI-VOL READINGS WERE MADE
0
5
10
SCALE, DAYS
NO. OF DAYS OVER 75 μg/m3
TOTAL NO. OF DAYS HI VOL. WAS RUN
15
57

Figure 2.1. Pollution roses at Las Vegas hi-vol sites.

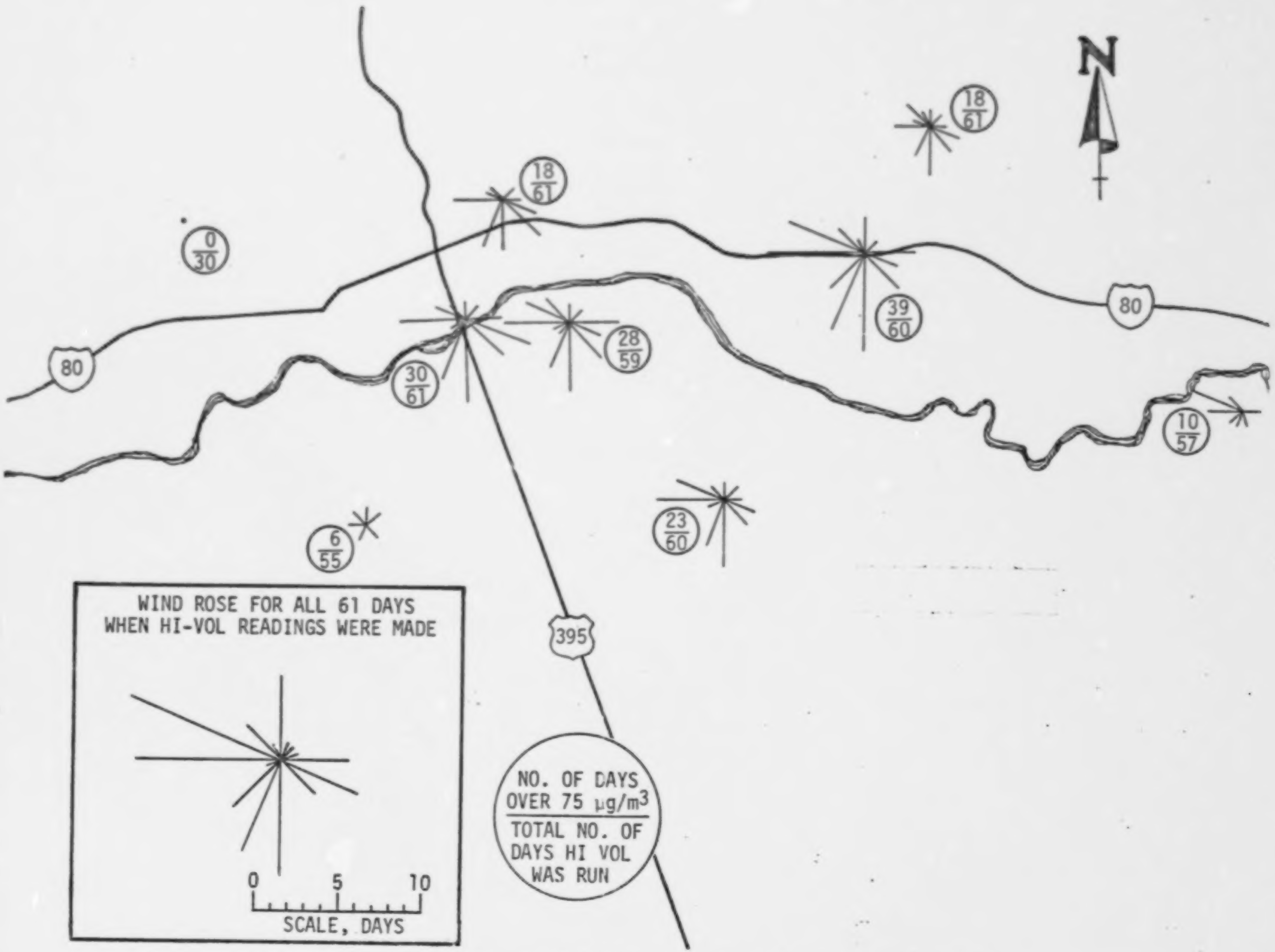

N
18/61
18/61
0/30
39/60
80
80
30/61
28/59
10/57
23/60
6/55
395
WIND ROSE FOR ALL 61 DAYS
WHEN HI-VOL READINGS WERE MADE
0
5
10
SCALE, DAYS
NO. OF DAYS OVER 75 μg/m3
TOTAL NO. OF DAYS HI VOL WAS RUN

Figure 2.2. Pollution roses at Reno hi-vol sites.

It can be seen that the pollution roses tend to follow the same distribution as the wind rose. The standard is most often exceeded when the wind blows from the southwest because that is the direction of the most frequent wind. The most significant deviation of pollution rose pattern from the wind rose pattern is observed at Nellis Air Force Base and Basic School. The NAAQS at Nellis was exceeded only when the wind blew from the southwest and northwest. The pollution rose at Basic School was more uniform than the others.

The pollution roses do not indicate the presence of major local sources. These sources appear when the pollution roses "point" toward a local area. The non-uniform wind rose for the sampling dates aids in masking this effect. The fact that the pollution roses closely resemble the wind rose for the days samples were taken indicates there is equal likelihood that the standard will be exceeded when the wind blows in any direction. The pollution roses "point" in certain directions because of the more frequent winds.

The pollution roses for Reno are shown in Figure 2.2. For the sites not shown, 2 of 61 readings at Lake Tahoe, none of the 60 readings at Verdi School, and 10 of 59 readings at Wadsworth exceeded the standard.

A wind rose of the days when samples were taken was prepared for Reno and is also shown in Figure 2.2. The pollution roses and wind rose are seen to have similar distributions. The major difference is that the pollution roses do not reflect as strong a north and west-northwest influence as the wind rose. This indicates there is approximately equal probability that the standard will be exceeded when the wind blows in any direction; however, there are relatively fewer days that the NAAQS is exceeded when the wind blows from the north and west-northwest. Therefore, high particulate concentrations are not associated with specific wind directions.

The pollution roses with the greatest deviation from the wind rose are at the Sewer Plant and Beck School. The Sewer Plant rose is predominately to the west-northwest. However, there are few days when the standard was exceeded (10) and the site is sheltered to the south and southeast by mountains. Beck School displays a uniform pollution rose with six readings in excess of the standard and each in a different direction. These few data points make difficult the development of a pattern. There were no violations at Mamie Towles School in the six months of operation.

FREQUENCY DISTRIBUTIONS AND CHI SQUARE TEST

Frequency distributions of air quality data were used to determine days with high and low region-wide concentrations. The October 1974 through September 1975 air quality data for each monitoring station were listed from lowest to highest, then divided into 5 fractiles. Next it was determined, for each day, the fractile in which the concentration for each station fell. The observed number of stations in each fractile were then compared to the expected number under the conditions of chance. A decision as to whether the difference between observed (O) and expected (E) frequencies was statistically significant was made using the chi square (χ^2) test. The procedure for the χ^2 test is as follows:

Fractile	Number of stations Observed O_i	Expected E	$O_i - E$	$\frac{(O_i - E)^2}{E}$
1 (low)	O_i	N/5		
2	O_2	N/5		
3	O_3	N/5		
4	O_4	N/5		
5 (high)	O_5	N/5		
	$\Sigma = \overline{N}$			$\Sigma\left[\frac{(O_i - E)^2}{E}\right]$

$$\chi^2 = \Sigma\left[\frac{(O_1 - E)^2}{E}\right]$$

The χ^2 for 5-1 = 4 degrees of freedom and a risk level of 5 percent is 9.49. Thus, if the calculated value of χ^2 was greater than 9.49, it can be stated that the difference between the observed and expected frequencies is statistically significant at the 5 percent level. This analysis indicates if the readings on any one day are "clustered," i.e., fall into just a few fractiles.

The χ^2 analysis for each date is shown in Appendix B. Las Vegas Wash and Mamie Towles School sites were not included in the analysis because they had less than 75 percent of the possible samples. In addition the Lake Tahoe, Verdi, and Wadsworth stations were not included because of their remoteness from the Reno urban area. Results show that the air quality data was significantly grouped on 33 of the 61 sampling days in Las Vegas and 39 of the 61 sampling days in Reno. Thus, for more than half the time concentrations in either area moved up or down together. This indicates a strong pattern of region-wide particulate impact. However, this is not to say that concentrations are the same throughout the region, only that on any day readings at most stations tend to be grouped in the same fractile (high, low, or middle).

The χ^2 analysis was used to identify the days with high and low region-wide concentrations. These days are listed in Table 2.1.

The selection criteria for high and low pollution days were a statistically significant χ^2 and all the readings in the highest or lowest two fractiles. Exceptions were made to include a few days with readings outside the two fractiles. The data show there were three coincident dates when high regional concentrations were recorded in both Las Vegas and Reno. There were also three dates when low regional concentrations were recorded in both areas. In addition, on two dates readings were high in one region and low in the other.

SEASONAL GEOMETRIC MEANS

Geometric means were calculated by quarter for each hi-vol site (see Appendix A). These data are shown in Figures 2.3 and 2.4 for Las Vegas and Reno respectively.

The Las Vegas data do not show any significant overall seasonal trends. The October-December to January-March changes show concentrations at seven sites increase, three decrease, and two remain approximately the same. Although seven of 12 increase, there is not a major change in the distribution of the means. The January-March to April-June changes show five increase and seven decrease. This is a very uniform movement indicating no trend. The April-June

Table 2.1. DAYS WITH HIGH AND LOW REGION-WIDE PARTICULATE CONCENTRATIONS

High Concentrations		Low Concentrations	
Las Vegas	Reno	Las Vegas	Reno
10/2/74[a]	10/2/74[a]	11/1/74[b]	11/1/74[b]
11/13/74[a]	10/14/74	12/7/74	1/6/75
11/20/74	10/20/74	12/31/74[d]	3/13/75
1/24/75[a]	11/7/74	2/5/75	3/19/75
3/25/75[c]	11/13/74[a]	4/6/75[b]	3/25/75[c]
6/17/75	12/19/74	4/12/75	4/6/75[b]
7/29/75	12/31/74[d]	4/18/75[b]	4/18/75[b]
	1/12/75	5/6/75	6/29/75
	1/18/75		8/28/75
	1/24/75[a]		9/9/75
	2/11/75		9/15/75
	3/1/75		

[a] High particulate concentration at both Las Vegas and Reno.

[b] Low particulate concentration at both Las Vegas and Reno.

[c] High particulate concentration at Las Vegas and low at Reno.

[d] High particulate concentration at Reno and low at Las Vegas.

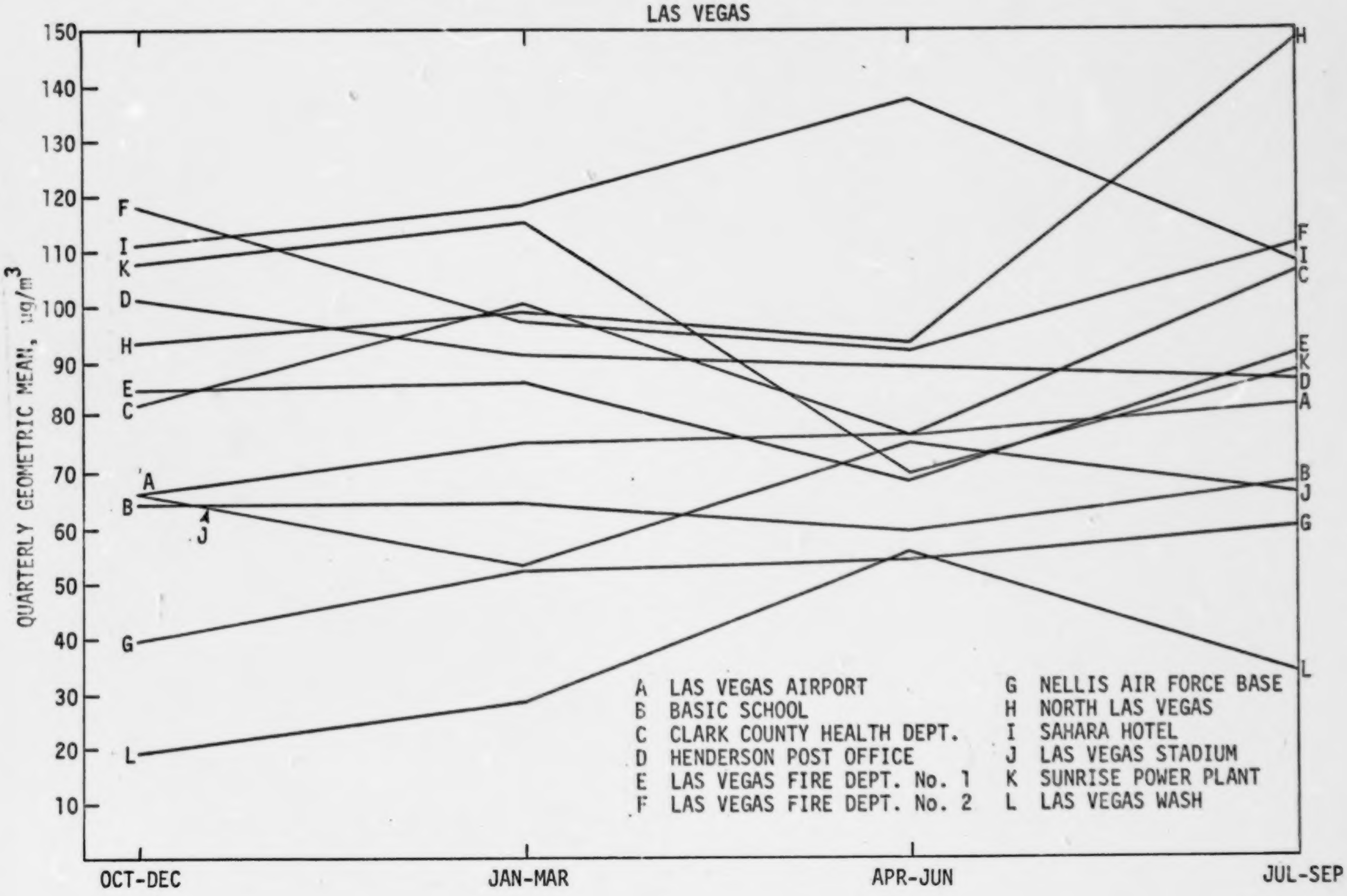


Figure 2.3. Geometric means by season for Las Vegas.

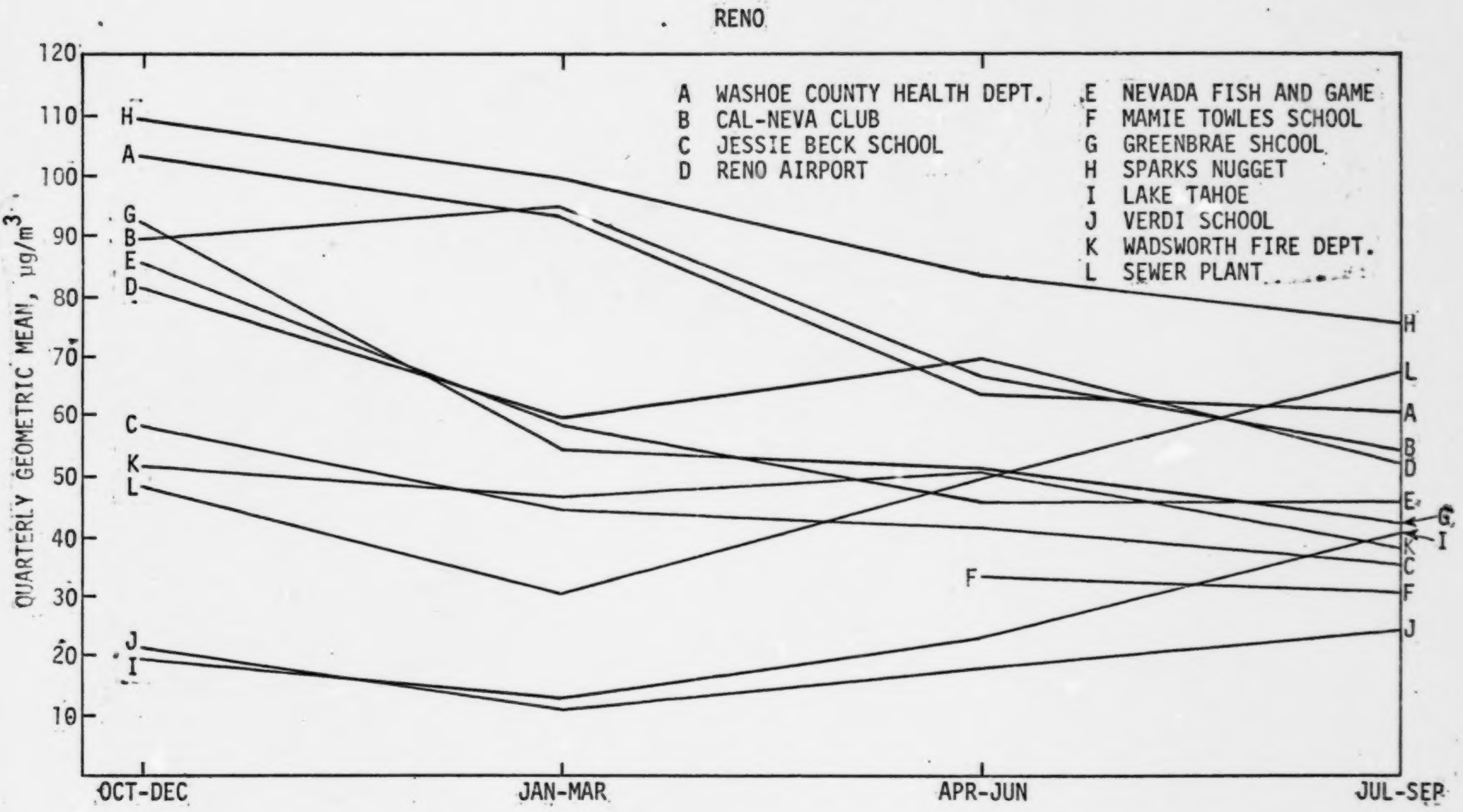


Figure 2.4. Geometric means by season for Reno.

to July-September changes show eight increase and four decrease. This pattern is not strong enough to indicate a general trend. Seven of the July-September (1975) means were higher than the October-December (1974) means while four were lower and one mean remained about the same. This again does not indicate a seasonal trend.

The days identified as having high region-wide concentrations in Las Vegas were predominately in the October to March quarters (winter) and the days with low region-wide concentrations were predominately in the January to June quarters. However, the seasonal means did not reflect this trend.

The Reno data do show a seasonal trend. There is a decline in geometric mean concentrations between the October-December and January-March quarters for all hi-vol sites except one. The random movement between the January-March and April-June means (five increase and six decrease) shows no trend. For the April-June to July-September changes, eight means decrease, three increase, and one remains the same. These changes are not indicative of a strong trend. Eight of the October-December (1974) means were higher than in July-September (1975) and three were lower. This does not significantly indicate a trend.

In Reno, all of the days with high region-wide concentrations were in the October to March quarters. The low region-wide concentrations were in the January to September quarters. The seasonal geometric means agree with this trend.

AMBIENT PARTICLE SIZE DISTRIBUTION

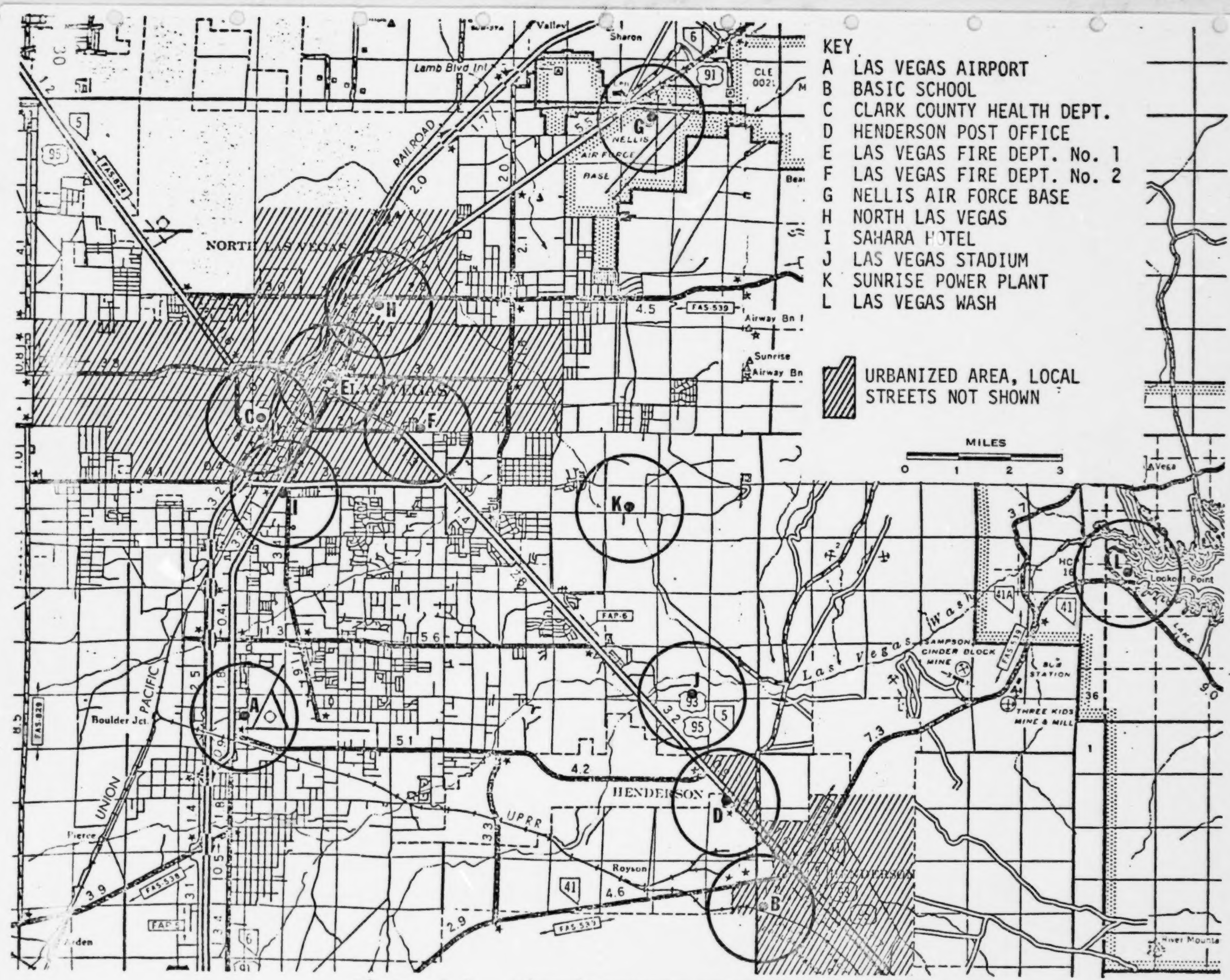
The Clark County District Health Department operated 2 Andersen samplers on 6 days during December 1975 and January 1976. The Washoe County District Health Department has taken 3 particle size samples at 6 sites. Their work is continuing. The ambient particle size distribution data obtained from this work is not yet available but will be evaluated later.

3. MICROINVENTORIES

The area within a 1.0 mile radius surrounding each hi-vol location was surveyed to determine specific sources and source categories influencing measurements at the site. This survey or "microinventory" technique was developed and applied to similar studies by PEDCo in Kansas-Nebraska,[2] Wyoming, and South Dakota[3] and has demonstrated reasonably good accuracy and reproducibility in correlating emission estimates from ground level sources with measured air quality.

The microinventory survey areas for Las Vegas and Reno are shown in Figures 3.1 and 3.2 respectively. Because of their distances from the urban area, the Lake Tahoe, Verdi School, and Wadsworth sites are not shown in Figure 3.2. The 1.0 mile radius about each sampler was specified because that is approximately the range to which theoretical treatments (dispersion modeling) show that ground level sources will have a significant impact.

The survey procedure employed to provide the best observation of overall site exposure was to ground survey, via automobile, the sampler stations and all probable sources of emissions surrounding the site. Sources of fugitive dust and conventional point and area sources were located on the appropriate USGS map and labeled with pertinent data, such as size and boundaries, observed activity and operational characteristics, and any other important parameters. Two observers independently estimated and agreed upon parameters observed at each site to increase accuracy and completeness.


KEY
A LAS VEGAS AIRPORT
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D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. No. 1
F LAS VEGAS FIRE DEPT. No. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
URBANIZED AREA, LOCAL STREETS NOT SHOWN
MILES
0
1
2
3
NORTH LAS VEGAS
LAS VEGAS
HENDERSON
NELLIS AIR FORCE BASE
RAILROAD
UNION PACIFIC
UPRR
Boulder Jct.
Pierce
Arden
Royson
Lamb Blvd Int
Valley
Sharon
Sunrise Airway Bn
Las Vegas Wash
SAMPSON CINDER BLOCK MINE
BUS STATION
THREE KIDS MINE & MILL
Lookout Point
LAKE
River Mountain

Figure 3.1. Microinventory areas for Las Vegas.

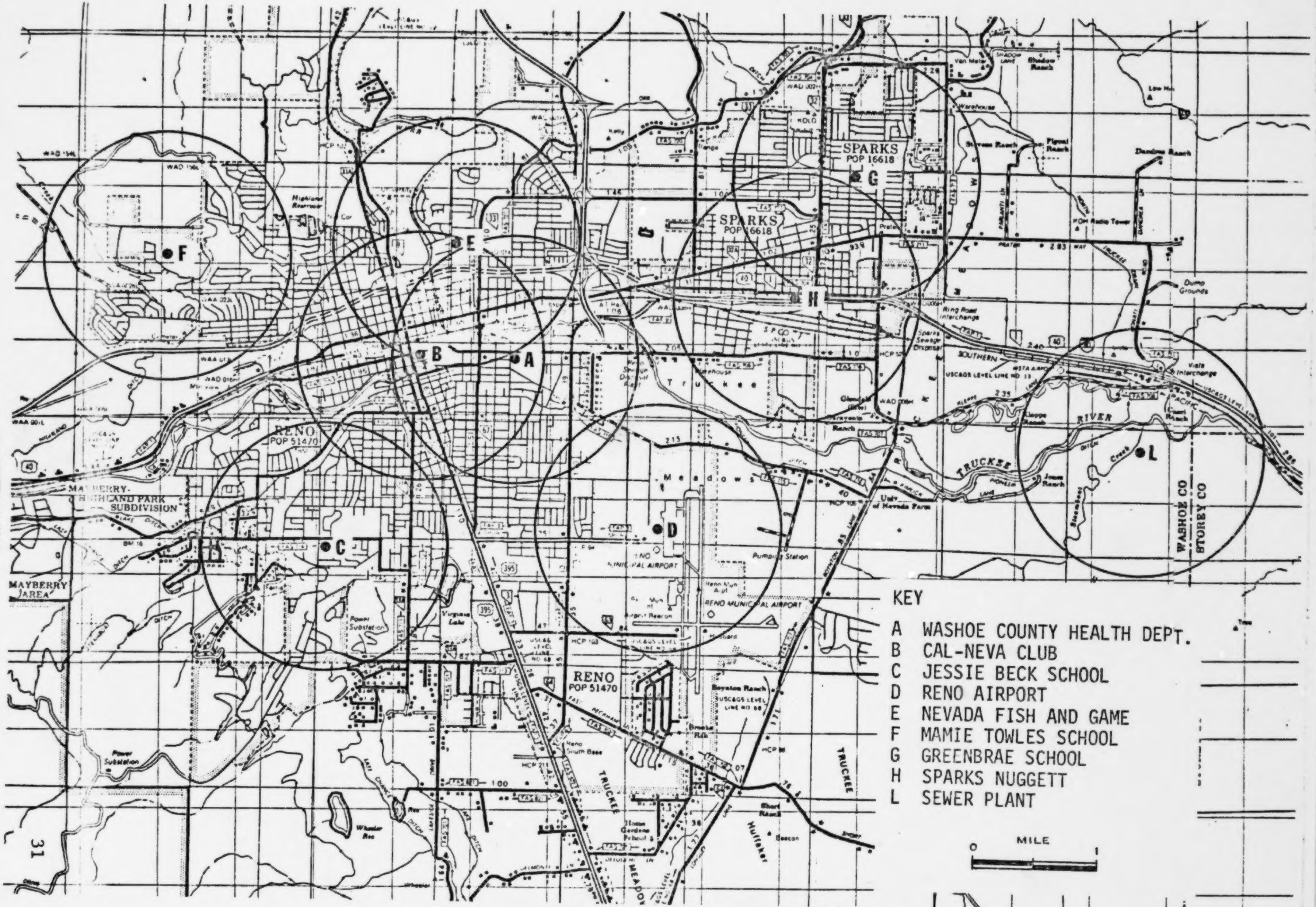
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
L SEWER PLANT
0 MILE 1
SPARKS POP 16618
SPARKS POP 16618
RENO POP 51470
RENO POP 51470
MAYBERRY-HIGHLAND PARK SUBDIVISION
MAYBERRY AREA
RENO MUNICIPAL AIRPORT
Meadows
Truckee
TRUCKEE RIVER
SOUTHERN PACIFIC
WASHOE CO
STOREY CO
TRUCKEE
Pumping Station
Power Substation
Virginia Lake
Huffaker

Figure 3.2. Microinventory areas for Reno.

From the survey data, estimates were made of particulate emissions in each area. All identified sources within each microinventory were listed with estimates of size and activity. Appropriate emission factors were then applied to each source to calculate estimated annual emissions. Conventional area and point source emissions not accounted for by the survey were added to get total particulate emissions in each survey area. This was divided by the area of the microinventory (3.14 mi^2) to obtain emission density ($ton/mi^2/yr$). The microinventories for each site are presented in Appendix C and summarized in Tables 3.1 and 3.2. Included in these tables are the percent of emissions attributable to fugitive dust sources.

The emission factors for fugitive dust sources are presented in the Task B report. Variations in emission factors are accounted for by differences in climate of the geographic areas, i.e, wind speed, soil erosion parameters, and precipitation-evaporation indices. Two emission estimates were made for each microinventory using two different emission factors for dust from paved streets. The data in parentheses are based on a recently developed and as yet unpublished emission factor. Additional investigation must be done to determine which factor will be used.

Emission factors were also used for the conventional area source categories. Estimates were made of the emission level parameters (such as vehicle-miles traveled and aircraft landing takeoff cycles) for each microinventory. Stationary area source fuel combustion in Las Vegas was estimated to be negligible since natural gas is the primary fuel used.[4] Point source data were obtained from NEDS.

The survey method and fugitive dust emission factors are both relatively imprecise. However, the results should

Table 3.1. MICROINVENTORY SUMMARY FOR LAS VEGAS

Site	Percent fugitive dust	Emission density ton/mi^2/yr	Annual geometric mean
Airport	74 (89)[a]	72 (166)	69
Basic Jr. High	46 (58)	126 (164)	64
Clark Co. Health Department	89 (96)	236 (666)	91
Henderson Post Office	62 (76)	164 (258)	92
Las Vegas F.D. No. 1	90 (96)	182 (530)	82
Las Vegas F.D. No. 2	89 (96)	85 (264)	105
Nellis A.F.B.	81 (94)	27 (89)	51
North Las Vegas	87 (96)	98 (338)	105
Sahara Hotel	90 (96)	277 (667)	117
Stadium	92 (97)	38 (93)	64
Sunrise Power Plant	36 (37)	79 (80)	92
Las Vegas Wash	89 (96)	2 (6)	32

[a] Based on recently developed and as yet unpublished data.

Table 3.2. MICROINVENTORY SUMMARY FOR RENO

Site	Percent fugitive dust	Emission density ton/mi^2/yr	Annual geometric mean
Health Department	77 (93)[a]	252 (617)	77
Cal-Neva Club	61 (92)	152 (723)	74
Jessie Beck School	52 (86)	52 (195)	44
Reno Airport	72 (92)	43 (141)	65
Nevada Fish & Game	76 (94)	160 (598)	57
Mamie Towles School	44 (67)	88 (146)	32
Greenbrae School	54 (82)	68 (169)	58
Sparks Nugget	67 (89)	99 (287)	90
Lake Tahoe	38 (77)	16 (44)	22
Verdi School	77 (92)	10 (30)	18
Wadsworth Fire Dept.	89 (94)	4 (7)	46
Sewer Plant	74 (95)	24 (36)	50

[a] Based on recently developed and as yet unpublished data.

still be of sufficient accuracy for their two primary purposes:

1. identification of the types of particulate emission sources impacting on each sampling site; and
2. Estimation of the approximate percentages of suspended particulate at each site attributable to fugitive dust sources.

4. DATA ANALYSIS AND CORRELATIONS

SAMPLING SITE EVALUATION

The project team inspected each TSP sampling site in both the Las Vegas and Reno study areas and evaluated each for the following three factors:

- General site location (GSL).
- Localized dominating pollution influence (DPI).
- Possible physical interferences (PPI).

The results of these observations are summarized in the following sections using the above noted abbreviations.

Las Vegas

- Site A: Las Vegas Airport

  GSL - Suburban/commercial
  DPI - Reintrained particulate from aircraft operations and wind-blown dust
  PPI - Exposure partially blocked by nearness (5 ft.) to adjacent 2-story building

- Site B: Basic School

  GSL - Suburban/residential
  DPI - Unpaved parking lot and R.R. right-of-way
  PPI - None, good exposure

- Site C: Clark County Health Department

  GSL - Center city/commercial
  DPI - None apparent
  PPI - None, good exposure

- Site D: Henderson Post Office

  GSL - City/industrial/commercial
  DPI - Unpaved parking lot (heavy usage) adjacent to site
  PPI - None, good exposure

- Site E: Fire Department No. 1

  GSL - Center city/commercial
  DPI - None apparent
  PPI - Exposure slightly blocked (NE) by trees

- Site F: Fire Department No. 2

  GSL - Center city/commercial
  DPI - Large disturbed open area and unpaved road adjacent to site
  PPI - Exposure slightly blocked (N) by fire tower

- Site G: Nellis Air Force Base

  GSL - Suburban/commercial
  DPI - None apparent
  PPI - None, good exposure

- Site H: North Las Vegas

  GSL - City/commercial
  DPI - Unpaved roads and parking areas
  PPI - None, good exposure

- Site I; Sahara Hotel

  GSL - Center city/commercial
  DPI - Reintrained particulate from highway and disturbed open areas
  PPI - Exposure restricted by adjacent buildings on several sides

- Site J: Las Vegas Stadium

  GSL - Suburban/commercial
  DPI - Large, unpaved parking areas
  PPI - Exposure slightly blocked by stadium structure

- Site K: Sunrise Power Plant

  GSL - Suburban/industrial
  DPI - Unpaved parking areas plus adjacent sand/ gravel operations and storage piles
  PPI - None, good exposure

- Site L: Las Vegas Wash

  GSL - Rural/recreational
  DPI - Large unpaved parking areas
  PPI - None, good exposure

Reno

- Site A: Washoe County Health Department

  GSL - Suburban/commercial
  DPI - None apparent
  PPI - None, good exposure

- Site B: Cal-Neva Club

  GSL - City/commercial
  DPI - None apparent
  PPI - Facade around building roof partially blocks exposure and may cause reintrainment

- Site C: Jessie Beck School

  GSL - Suburban/residential
  DPI - Adjacent playground, unpaved
  PPI - None, good exposure

- Site D: Reno Airport

  GSL - Suburban/commercial
  DPI - Reintrained particulate from aircraft operations
  PPI - None, good exposure

- Site E: Nevada Fish and Game

  GSL - Suburban/residential
  DPI - Adjacent to active agricultural area (experimental farm)
  PPI - None, good exposure

- Site F: Mamie Towles School

  GSL - Suburban/residential
  DPI - Adjacent to unpaved playground and active construction
  PPI - None, good exposure

- Site G: Greenbrae School

  GSL - Suburban/residential, commercial
  DPI - Adjacent playground, unpaved
  PPI - None, good exposure

- Site H: Sparks Nuggett

  GSL - City/commercial
  DPI - Reintrained particulate from Interstate highway
  PPI - Facade around building partially blocks exposure and may cause reintrainment

- Site I: Lake Tahoe

  GSL - Suburban/commercial
  DPI - None apparent
  PPI - Exposure influenced by heavy, tall trees

- Site J: Verdi School

  GSL - Rural/residential
  DPI - Adjacent playground, unpaved
  PPI - None, good exposure

- Site K: Wadsworth Fire Department

  GSL - Rural/agricultural
  DPI - Adjacent to unpaved parking lot
  PPI - None, good exposure

- Site L: Sewer Plant

  GSL - Rural/agricultural
  DPI - Unpaved service roads
  PPI - None, good exposure

METEOROLOGICAL CONDITIONS AND AIR QUALITY

The local meteorlogical conditions are summarized in Tables 4.1 through 4.4 for the days with high and low particulate concentrations.

Las Vegas

For Las Vegas, there was more rain on or preceding the days with low concentration. Not all low days had rain, however. Four of these days had no rain or only a trace on the day of the reading or the three previous days. Two of the seven high concentration days had rain. High readings on days with rain may be due to strong winds preceding the storm. On October 2, 1974 the rain started after 9:00 p.m. and was preceded by six hours of wind at approximately 18 mph. High winds were present throughout the entire day on March 25, 1975.

The average wind speeds were approximately the same for days with high and low concentrations. Three of the high days had average speeds greater than or equal to 16 mph while highest average speed for a low concentration day was 14.7 mph. There were also three high concentration days with average speeds less than 7 mph and the lowest average speed for a low concentration day was 7.6 mph.

The predominate wind directions for the high concentration days were predominantely from the southwest and south, and occasionally from the west or northwest. For the low concentration days, the wind was generally from the northeast and west, but occasionally from the southwest or northwest. High regionwide concentrations were not recorded when there were winds from the northeast.

All of the high readings fell on a weekday, mostly a Tuesday or Wednesday. The low readings were equally distributed throughout the week.

Table 4.1. METEOROLOGICAL CONDITIONS AT LAS VEGAS ON DAYS WITH HIGH PARTICULATE CONCENTRATIONS

Date	Day of week	Average wind speed (mph)	Resultant direction	Predominant direction (hours)	Fastest mile		Precipitation									Avg. temp. (°F)	Average relative humidity (%)
							Day of reading			Previous day		2nd Prev. day		3rd Prev. day			
					speed (mph)	Dir.	Rain/ water equiv. (in.)	Snow/ ice (in.)	Snow/ice on ground @ 4 AM (in)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)		
10/2/74	Wed	9.4	SW	S (6), SW (6), NW (6)	30	S	0.12	0	0	0	0	0	0	0	0	81	22
11/13/74	Wed	5.0	WNW	W (9)	9	W	0	0	0	0	0	0	0	0	0	59	38
11/20/74	Wed	6.0	WSW	SW (12), W (3)	Unknown but >10	W	0	0	0	0	0	0	0	0	0	56	44
1/24/75	Thurs	6.5	WSW	NW (12)	10	W	0	0	0	0	0	0	0	0	0	52	26
3/25/75	Tues	25.0	WSW	SW (12), S (6)	42	SW	0.07	0	0	0	0	0	0	0	0	57	40
6/17/75	Tues	17.4	SSW	SW (15), S (9)	34	SW	0	0	0	0	0	0	0	0	0	86	14
7/29/75	Tues	16.0	SW	SW (12), S (9)	30	SW	0	0	0	0.03	0	0	0	0	0	90	29

Table 4.2. METEOROLOGICAL CONDITIONS AT LAS VEGAS ON DAYS WITH LOW PARTICULATE CONCENTRATIONS

Date	Day of week	Average wind speed (mph)	Resultant direction	Predominant direction (hours)	Fastest mile		Precipitation									Avg. temp. (°F)	Average relative humidity (%)
							Day of reading			Previous day		2nd Prev. day		3rd Prev. day			
					speed (mph)	Dir.	Rain/ water equiv. (in.)	Snow/ ice (in.)	Snow/ice on ground @ 4 AM (in)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)		
11/1/74	Fri	8.6	NNW	W (12)	14	SW	0.02	0	0	0.01	0	0	0	T	0	52	64
12/7/74	Sat	8.3	ENE	NE (9), E (3)	20	N	0	0	0	0	0	0	0	0.43	0	49	51
12/31/74	Tues	14.2	N	NE (15), N (9)	25	N	0	0	0	0	0	0.02	T	0.14	T	41	37
2/5/75	Wed	7.6	NE	NE (15)	12	NE	0	0	0	0	0	T	0	0	0	48	34
4/6/75	Sun	14.7	W	SW (9), W (6), N (6)	24	SW	0	T	0	0	0	0	0	0	0	50	37
4/12/75	Sat	9.2	NW	W (12)	23	NW	0	0.03	0	0.20	0	0.01	0	0.04	0	57	49
4/18/75	Fri	10.8	W	S (9), W (9)	18	NE	0	0	0	T	0	0	0	0	0	56	28
5/6/75	Tues	9.8	NW	NW (12)	21	NW	0	0	0	0	0	0	0	0	0	59	20

Table 4.3. METEOROLOGICAL CONDITIONS AT RENO ON DAYS WITH HIGH PARTICULATE CONCENTRATIONS

							Precipitation									
							Day of reading			Previous day		2nd Prev. day		3rd Prev. day			
					Fastest mile												
Date	Day of week	Average wind speed (mph)	Result-ant direct-ion	Predominant direction (hours)	speed (mph)	Dir.	Rain/ water equiv. (in.)	Snow/ ice (in.)	Snow/ice on ground @ 4 AM (in)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Avg. temp. (°F)	Average relative humidity (%)
10/2/74	Wed	2.9	W	Calm (9)	13	S	0	T	0	0	0	0	0	0	0	58	46
10/19/74	Mon	3.3	ESE	Calm (9)	10	E	0	0	0	0	0	0	0	0	0	52	48
10/20/74	Sun	9.5	NW	SE (6)	24	W	0	0	0	0	0	0	0	0	0	54	41
10/7/74	Mon	5.9	SE	SE (12)	15	SE	0	0	0	0	0	0	0	0	0	49	49
11/13/74	Wed	1.4	S	Calm (15)	3	SW	0	0	0	0	0	0	0	0	0	47	60
12/19/74	Thurs	1.0	NE	Calm (18)	7	NE	0	0	0	0	0	0	0	0	0	32	69
12/31/74	Tues	1.0	S	Calm (18)	6	NE	0	0	2	0.07	1.2	0	0	0.17	2.4	12	87
1/12/75	Sun	0.3	SE	Calm (21)	5	SW	0	0	0	0	0	0	0	0.01	0.1	33	77
1/18/75	Sat	0.9	SSW	Calm (18)	8	N	0	0	0	0	0	0	0	0	0	39	73
1/24/75	Fri	1.6	ESE	Calm (15)	5	S	0	0	0	0	0	0	0	0	0	43	70
2/11/75	Tues	2.5	SE	Calm (12), SE (6)	9	SW	0	0	2	0.21	2.2	0.55	3.0	T	0	31	78
3/1/75	Sat	12.4	SSW	Calm (9), SW (6), S(6)	40	SW	0	0	0	0	0	0	0	0	0	46	56

Table 4.4. METEOROLOGICAL CONDITIONS AT RENO ON DAYS WITH LOW PARTICULATE CONCENTRATIONS

Date	Day of week	Average wind speed (mph)	Result-ant direct-ion	Predominant direction (hours)	Fastest mile		Precipitation									Avg. temp. (°F)	Average relative humidity (%)
							Day of reading			Previous day		2nd Prev. day		3rd Prev. day			
					speed (mph)	Dir.	Rain/ water equiv. (in.)	Snow/ ice (in.)	Snow/ice on ground @ 4 AM (in)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)	Rain/ water equiv. (in.)	Snow/ ice (in.)		
11/1/74	Fri	8.5	N	N (18)	15	NW	0.12	0	0	0.35	0	0	0	T	0	40	70
1/6/75	Mon	10.4	WNW	W (12)	23	W	T	0	T	0	0	T	0	T	T	44	70
3/13/75	Thurs	6.6	ENE	NE (6), SE (6)	20	W	0.23	1.6	0	0	0	0.02	0.6	T	T	38	71
3/19/75	Wed	18.4	S	S (21)	35	S	T	0	0	0	0	0	0	0.11	3.6	51	44
3/25/75	Tues	16.3	N	N (12)	33	NW	0.28	0.6	0	0.05	0	0	0	0.04	0.4	34	70
4/6/75	Sun	4.3	NNE	Calm (9)	22	NE	T	T	1	0.25	2.5	0.10	1.0	T	T	32	72
4/18/75	Fri	12.1	W	W (9), SW (6), Calm (6)	28	NW	0	0	0	T	T	0.04	0.3	0.01	0.2	42	49
6/29/75	Sun	5.8	SW	W (9), SW (6)	26	W	0	0	0	0	0	0	0	0	0	61	35
8/28/75	Thurs	8.5	W	W (9), NW (6), Calm (6)	24	NW	0	0	0	0	0	0	0	0	0	61	39
9/9/75	Tues	6.0	ESE	NE (6), S (6)	22	NE	0.40	0	0	0	0	0	0	0	0	72	52
9/15/75	Mon	5.2	NNE	NE (6), Calm (6)	13	N	T	0	0	0	0	T	0	0	0	67	54

Reno

There was rain or snow on several occasions on or preceding low concentration days. Again, not all low concentration days were associated with rain or snow. Four of the days had no precipitation or only a trace on the day of the reading or the three previous days. High concentration days had very little precipitation except for two days with snow cover.

It is anticipated that sand on paved streets for snow control has an impact on the ambient particulate concentrations. The low concentration days with snow had average temperatures above freezing which indicates the possibility of wet roads thus reducing the impact from road sanding. One of the two high concentration days with snow cover (December 31, 1974) had temperatures below freezing so the streets may have remained dry, increasing the impact from road sanding. The other high concentration day with snow cover (February 11, 1975) had temperatures above freezing, indicating the possibility of wet streets. However, the snow fell in the early morning the previous day and temperatures were warm enough that day (43° F) to possibly enable the streets to dry.

The days with high concentrations had a predominance of calm winds. With calm winds, particulates are not quickly dispersed but remain suspended in areas where they were generated. The two high concentration days that were not calm had prevaling winds (7 to 10 mph) from the southeast.

Only one low concentration day had predominately calm winds. The average wind speed that day was 4 mph. Six of the 11 low days had average winds of 5 to 8 mph and the remaining days had average winds from 10 to 18 mph. The wind directions on low concentration days were mostly from the west through north quadrant and occasionally from the south.

The high and low concentration days were evenly distributed throughout the week.

STATEWIDE AIR QUALITY AND METEOROLOGY

Identification of high and low concentration days in Las Vegas and Reno resulted in an unusual observation. Three of the high and three of the low days in both areas out of a possible seven were the same (see Table 2.1). To investigate this further, air quality data at the other hi-vol sites in the state plus mesoscale meteorological data were obtained and analyzed.

Statewide Air Quality Data

Air quality data for the 13 additional hi-vol sites in the state were divided into ten fractiles and the distribution determined for the three high and three low days. October 2, 1974 was the only day with high readings in Reno and Las Vegas that had significantly high readings throughout the state. Of the nine samples outside the study areas, six were in the highest 10 percent fractile. Applying the χ^2 analysis, the distribution was significant at the 0.5 percent level. Distributions on the other two high days were not statistically significant. However, five of 11 readings on November 13, 1974 were in the top two deciles and six of ten readings were in the top three deciles on January 24, 1975.

For the three days with low readings in both Las Vegas and Reno, the distributions by fractile of data throughout the rest of the state were significantly grouped on two of these days. The distribution on November 1, 1974 showed six of the ten readings in the lowest fractile and two in the second lowest fractile. This distribution was significant at the 0.5 percent level. Ten of 13 readings on April 6, 1975 were in the lowest of three deciles. This distribution was significant at the 5 percent level. While the distribution on April 18, 1975 was not significantly grouped, six of 11 readings were in the lowest three deciles.

Regional Meteorology

National weather maps were analyzed for all days with high and low concentrations in Las Vegas and Reno. The conditions obtained from the maps were frontal passage (type and day of passage), airmass type, and stability class. For both Las Vegas and Reno, there appeared to be no correlation between ambient concentration and meteorological condition. High and low concentrations were recorded on days with frontal passages and also on days with high pressure systems and low pressure systems.

The statewide meteorological conditions were investigated for the days with significant statewide trends. The conditions on October 2, 1974 were not unusual from other days when high or low concentrations were recorded in Las Vegas and Reno. Low concentrations were recorded November 1, 1974 when there was rain over all the state. Therefore, no apparent relationship between regional meteorological conditions (airmass type and movement) and particulate air quality was observed.

EMISSION DENSITY AND AIR QUALITY

Emission density from the microinventories and measured air quality at the hi-vol sites were compared to determine if a relationship exists. These data are summarized in Tables 3.1 and 3.2 and presented in Figure 4.1. Two total emission density values, separately tabulated using each of the paved street emission factors, have been used to construct the plots for each area. The data points and graph are individually given in Appendix D. A linear regression analysis was performed to determine the line of best fit. The analysis does not include data for Las Vegas Wash or Mamie Towles School because these sites recorded less than 75 percent of the possible air quality samples.

The correlation coefficients (r) were 0.61 and 0.60 for Las Vegas and 0.63 and 0.67 for Reno (depending on the paved street emission factor). These correlation coefficients are not significant enough for the emission density vs. air quality plot to form the basis of a source/receptor relationship. That is, determination of an emission density limit that would, with sufficient confidence, indicate that an annual geometric mean of 75 $\mu g/m^3$ would probably not be exceeded.

Background concentrations, identified by the intercept at zero emission density appear to be very realistic. The background estimates for Las Vegas are 31 or 39 $\mu g/m^3$, depending on paved street emission factors of 1.75 or 14 gm/VMT respectively. Background estimates for Reno are 21 or 20 $\mu g/m^3$, depending respectively on the 1.75 or 14 gm/VMT paved street emission factor used. These values should be used in the emission diffusion work (Task D) as average study area backgrounds.

Each pair of lines has nearly the same slope, indicating reasonable if not statistically significant relationship between emission density and particulate concen-

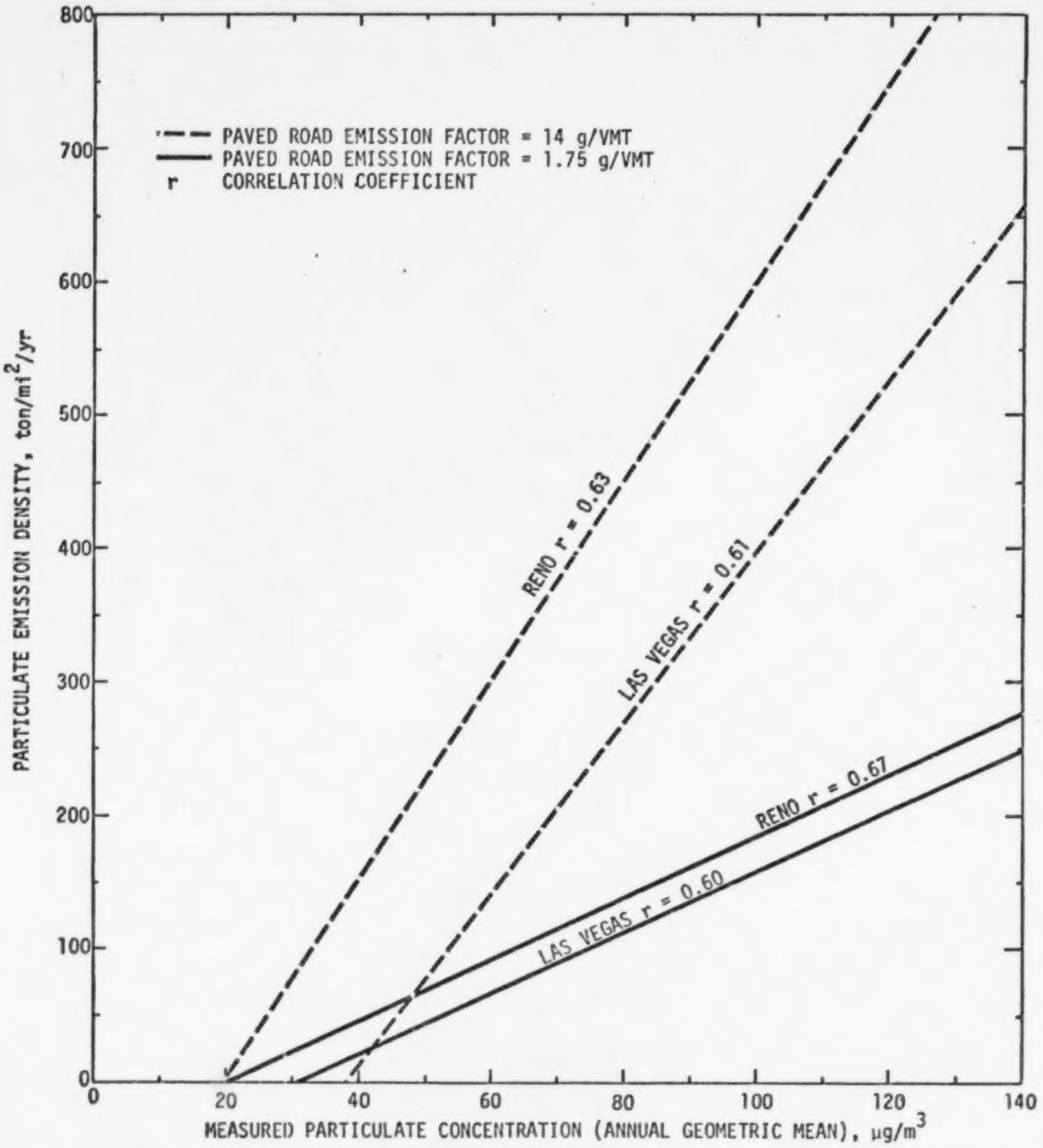

Figure 4.1. Emission density vs. air quality.

trations. Slopes similar to the steep pair were observed in other microinventory studies. For illustration, the following slopes for the noted relationship have been determined:

Study	Slope
Las Vegas (1.75 gm/VMT)	2.3
Reno (1.75 gm/VMT)	2.4
Las Vegas (14 gm/VMT)	6.6
Reno (14 gm/VMT)	7.5
Wyoming	8.3
South Dakota	6.0

The fact that slopes of the plotted relationship when using the 14 gm/VMT paved street emission factor for the study areas are similar to the emission density vs. air quality slopes in the Wyoming and South Dakota studies, adds some credibility to the new emission factor.

5. CONCLUSIONS

Based on the information tabulated and developed plus evaluation of the results of various analytical approaches to investigation of data parameters, a number of conclusions can be made. They are predicated on our best technical judgement and are aimed at resolution of the basic question concerning the impact of fugitive dust emissions on regional TSP air quality non-attainment.

Therefore, the following series of observations/conclusions have been developed:

- In the study areas, particulate air quality is usually regional rather than source oriented in nature. There are some indications that air quality may be influenced by meteorological conditions over a much larger area than the study areas, for instance state-wide. While data showed some correlation in daily particulate concentration changes at sampling sites throughout the state, no meteorological parameters were identified to explain these coincident changes.

- Strong seasonal trends are not apparent in the two study areas. The Reno air quality data do show a decrease in mean concentration from fall to winter, however, trends through the rest of the year are not as distinct. Las Vegas air quality data show no strong seasonal trends.

- The pollution roses in both areas closely resemble the wind roses for the days when samples were taken. This indicates there is approximately equal likelihood of high particulate concentrations when the wind blows from any direction. However, in Las Vegas days with the highest region-wide concentrations had winds predominately from the southwest or south.

- High particulate concentrations are not always associated with strong winds. Average wind speeds in Las Vegas were approximately the same for both high and low region-wide concentration days. High concentrations in Reno were usually on days with extended periods of calm winds. This indicates the significant fugitive dust sources may be activity rather than wind related.

- Microinventories demonstrate that fugitive dust sources are the major contributor to particulate emissions in both study areas. In Las Vegas, cleared areas and reintrained dust from paved streets represent the major fugitive dust categories. In Reno, there appears to be a more even distribution of emissions among many fugitive dust and conventional source categories; however, paved streets are still a major contributor. Naturally, the magnitude of paved street emissions is dependent on which of the two emission factors is used.

- The lack of a strong correlation between measured air quality and emission density may be due to one or more of the following reasons:

  - fine particles with long residence time in the atmosphere and impacting several miles from the source,

  - strong local influences on samplers (site bias),

  - inaccuracies in the "microinventory" technique primarily due to nonprecise emission factors.

  It does not appear that emission density vs. air quality can be used as the principal source/receptor relationship.

6. REFERENCES

1. Project Plan - Nevada Particulate Control Study for Air Quality Maintenance Areas. Contract No. 68-02-1375, Task Order No. 29, November 1975.

2. Fugitive Dust in Kansas and Nebraska. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. EPA Contract No. 68-02-0044, Task Order No. 14. February 1974.

3. Analysis of Suspended Particulate Sampling Sites in South Dakota AQMA's. PEDCo-Environmental Specialists, Inc., Kansas City, Missouri. EPA Contract No. 68-02-1375, Task Order No. 19. December 1975.

4. Personal communication - phone conversation on November 13, 1975 between Ann Pitchford, EPA, Las Vegas and Anthony Wisbith, PEDCo.

7. APPENDICES

A. AIR QUALITY DATA

Table A.1. AIR QUALITY DATA FOR LAS VEGAS

	Airport	Basic School	Health Dept.	Henderson Post Office	Las Vegas Fire Dept. #1	Las Vegas Fire Dept. #2	Nellis AFB	N. Las Vegas	Sahara Hotel	Stadium	Power Plant	Las Vegas Wash
10/2/74	140	106	147	267	161	199	87	136	212	192	177	96
10/8/74	60	62	43	77	56	82	36	62	125	47	93	5
10/14/74	59	69	62	130	60	144	33	67	105	54	169	7
10/20/74	85	64	-	151	-	150	-	95	116	128	88	45
10/26/74	42	58	-	67	-	86	-	69	76	47	62	-
11/1/74	36	34	53	63	48	86	29	70	83	27	-	-
11/7/74	64	78	104	83	93	187	38	-	104	-	-	-
11/13/74	105	104	157	145	143	218	76	205	262	82	168	7
11/20/74	85	72	148	162	109	208	66	124	178	88	176	29
11/25/74	75	96	150	151	133	175	52	120	129	88	158	-
12/1/74	87	72	113	114	94	159	54	137	97	89	123	32
12/7/74	40	-	71	68	58	78	16	91	75	43	54	-
12/13/74	93	47	-	70	85	93	-	88	107	35	86	-
12/19/74	79	-	124	-	139	175	-	141	175	-	142	-
12/25/74	45	-	32	-	39	68	-	59	53	-	-	-
12/31/74	37	27	31	45	-	28	13	44	62	-	49	-
Quarterly Geo. Mean	66	64	82	101	85	118	39	93	111	66	108	19
1/6/75	63	95	119	105	105	130	-	122	115	91	133	-
1/12/75	42	34	75	59	62	87	34	78	29	50	793	21
1/18/75	71	74	115	109	108	142	54	151	158	67	100	30

Table A.1 (continued). AIR QUALITY DATA FOR LAS VEGAS

	Airport	Basic School	Health Dept.	Henderson Post Office	Las Vegas Fire Dept. #1	Las Vegas Fire Dept. #2	Nellis AFB	N. Las Vegas	Sahara Hotel	Stadium	Power Plant	Las Vegas Wash
1/24/75	161	142	187	135	188	227	85	182	166	102	207	64
1/30/75	62	67	58	81	56	67	48	63	76	40	91	-
2/5/75	48	-	45	53	52	52	37	63	73	24	63	10
2/11/75	83	67	100	87	97	96	36	100	112	41	107	-
2/17/75	84	42	81	6	59	91	27	-	-	39	143	23
2/23/75	66	39	105	-	73	89	-	101	74	41	97	27
3/1/75	77	65	110	99	118	110	65	107	235	45	110	50
3/7/75	68	55	100	91	77	70	49	82	99	36	72	23
3/13/75	74	42	74	71	65	65	41	59	98	51	56	28
3/18/75											76	
3/19/75	62	71	107	70	90	92	86	96	84	45		12
3/25/75	134	89	247	231	108	167	122	131	331	156	128	-
3/31/75	105	74	110	102	93	89	53	122	376	70	108	80
Quarterly Geo. Mean	75	64	100	91	86	97	52	99	118	53	115	28
4/6/75	40	16	39	40	28	37	26	39	37	19	22	15
4/12/75	31	34	41	47	48	36	36	53	-	29	34	-
4/18/75	53	28	38	54	43	47	33	50	204	26	36	-

Table A.1 (continued). AIR QUALITY DATA FOR LAS VEGAS

	Airport	Basic School	Health Dept.	Henderson Post Office	Las Vegas Fire Dept. #1	Las Vegas Fire Dept. #2	Nellis AFB	N. Las Vegas	Sahara Hotel	Stadium	Power Plant	Las Vegas Wash
4/24/75	110	74	-	127	101	125	129	97	895	90	84	52
4/30/75	75	85	70	78	58	106	34	76	67	41	59	42
5/6/75	41	43	35	68	37	63	26	59	37	37	43	68
5/12/75	114	132	86	143	94	136	71	102	-	-	110	-
5/18/75	86	58	93	66	51	-	63	87	79	79	52	-
5/24/75	48	38	73	63	72	80	46	79	-	-	66	-
5/30/75	55	53	46	59	68	91	33	102	171	171	69	138
6/5/75	61	68	75	67	85	81	46	-	95	95	78	55
6/11/75	78	54	-	55	71	97	29	151	89	89	103	-
6/17/75	883	545	778	690	451	830	672	788	1129	868	569	131
6/23/75	86	85	103	167	80	140	75	128	151	151	95	55
6/29/75	72	33	116	174	51	69	62	77	-	-	59	40
Quarterly Geo. Mean	76	59	76	89	68	92	54	93	137	75	69	55
7/5/75	91	80	-	81	163	158	59	237	135	68	119	35
7/11/75	104	70	125	108	160	147	69	202	117	67	154	47
7/17/75	58	49	113	105	67	86	-	120	82	48	95	49
7/23/75	70	71	104	89	177	127	-	122	101	58	109	30
7/29/75	113	74	175	143	104	146	108	240	205	152	133	26

Table A.1 (continued). AIR QUALITY DATA FOR LAS VEGAS

	Airport	Basic School	Health Dept.	Henderson Post Office	Las Vegas Fire Dept. #1	Las Vegas Fire Dept. #2	Nellis AFB	N. Las Vegas	Sahara Hotel	Stadium	Power Plant	Las Vegas Wash
8/4/75	95	86	114	85	84	139	79	273	102	66	110	35
8/10/75	91	74	108	99	89	125	81	150	111	81	105	45
8/16/75	54	51	76	91	61	95	61	108	82	51	86	29
8/22/75	98	68	71	54	59	66	67	120	90	51	65	19
8/28/75	67	46	73	78	62	79	94	110	124	52	42	36
9/3/75	115	99	174	105	95	131	73	-	120	85	98	34
9/9/75	63	58	-	58	94	111	43	-	103	51	56	15
9/15/75	57	104	103	55	90	99	12	110	102	-	81	45
9/21/75	122	53	95	63	63	89	-	106	86	45	55	-
9/27/75	83	69	97	150	92	114	59	143	100	149	81	50
Quarterly Geo. Mean	82	68	106	87	91	111	60	148	108	67	88	34
Annual Geo. Mean	79	64	91	92	82	105	51	105	117	64	92	32

Table A.2. AIR QUALITY DATA FOR RENO

	Mamie Towles School	Reno Airport	Jessie Beck School	Cal-Neva Club	Health Dept.	Lake Tahoe	Sparks Nugget	Greenbrae School	Verdi School	Wadsworth	Nevada Fish & Game	Sewer Plant
10/2/74	-	173	103	134	-	76	134	128	54	119	130	88
10/8/74	-	60	51	82	-	24	65	45	24	48	57	32
10/14/74	-	94	54	89	126	36	133	95	33	91	80	51
10/20/74	-	181	87	121	186	29	174	366	49	61	153	106
10/26/74	-	99	54	82	94	31	100	187	34	52	86	64
11/1/74	-	22	38	43	36	6	32	17	7	30	22	12
11/7/74	-	121	54	86	113	12	154	71	13	57	81	52
11/13/74	-	128	65	110	182	23	197	161	38	69	189	96
11/19/74	-	100	56	84	107	14	152	125	29	45	111	48
11/25/74	-	40	33	47	54	25	-	55	9	60	58	37
12/1/74	-	92	50	89	104	16	141	137	21	67	100	62
12/7/74	-	30	32	76	60	7	62	50	11	31	64	21
12/13/74	-	71	55	92	101	12	84	81	16	30	83	33
12/19/74	-	100	96	162	204	18	137	135	17	72	149	-
12/25/74	-	87	75	83	86	16	90	78	27	50	70	-
12/31/74	-	80	74	121	139	22	140	91	15	25	89	63
Quarterly Geo. Mean	-	81	58	89	103	19	109	92	21	52	86	48
1/6/75	-	21	15	43	23	2	57	26	6	25	21	16
1/12/75	-	118	78	139	144	14	170	120	24	40	105	52
1/18/75	-	124	85	140	166	24	152	105	33	80	108	55

Table A.2 (continued). AIR QUALITY DATA FOR RENO

	Mamie Towles School	Reno Airport	Jessie Beck School	Cal-Neva Club	Health Dept.	Lake Tahoe	Sparks Nugget	Greenbrae School	Verdi School	Wadsworth	Nevada Fish & Game	Sewer Plant
1/24/75	-	124	64	154	234	26	206	139	17	40	149	59
1/30/75	-	58	52	98	165	49	95	60	17	35	68	26
2/5/75	-	57	52	89	102	7	83	38	20	19	64	18
2/11/75	-	-	64	202	200	10	142	77	12	33	124	39
2/17/75	-	66	48	144	134	20	115	73	12	21	84	29
2/23/75	-	84	45	80	92	30	113	65	18	45	79	31
3/1/75	-	114	49	132	156	29	298	96	23	109	87	50
3/7/75	-	43	37	91	70	6	69	40	3	44	45	26
3/13/75	-	37	29	57	65	16	48	28	7	25	30	26
3/19/75	-	31	22	58	37	10	106	30	4	44	42	21
3/25/75	-	30	35	60	43	12	43	23	6	364	23	18
3/31/75	-	47	46	62	52	10	44	38	8	59	24	23
Quarterly Geo. Mean	-	59	44	94	92	14	99	54	11	46	59	30
4/6/75	19	32	30	72	42	7	60	31	6	21	31	21
4/12/75	38	52	29	62	61	6	83	54	12	11	46	40
4/18/75	23	57	28	62	60	21	70	36	13	19	37	35
4/24/75	38	86	36	87	73	6	161	74	8	112	73	-

Table A.2 (continued). AIR QUALITY DATA FOR RENO

	Mamie Towles School	Reno Airport	Jessie Beck School	Cal-Neva Club	Health Dept.	Lake Tahoe	Sparks Nugget	Greenbrae School	Verdi School	Wadsworth	Nevada Fish & Game	Sewer Plant
4/30/75	40	72	59	70	86	20	89	79	30	60	62	57
5/6/75	28	51	44	61	52	11	64	49	13	29	25	27
5/12/75	47	60	50	68	84	21	67	53	51	54	42	40
5/18/75	40	53	35	57	62	43	77	48	21	44	50	43
5/24/75	37	90	50	69	62	41	79	52	21	162	41	71
5/30/75	50	60	55	73	64	25	87	82	32	62	60	66
6/5/75	37	113	-	71	80	32	85	57	20	65	54	65
6/11/75	49	129	50	77	86	38	110	61	34	84	72	99
6/17/75	2	200	38	66	69	61	71	53	20	168	41	82
6/23/75	2	83	-	54	52	74	134	40	22	62	56	56
6/29/75	1	34	-	48	41	34	62	29	12	25	26	38
Quarterly Geo. Mean	3	69	41	66	63	23	83	51	18	50	46	49
7/5/75	30	63	-	61	55	69	69	49	33	49	46	65
7/11/75	32	79	39	87	90	71	102	53	32	58	53	114
7/17/75	26	59	33	62	51	46	54	33	-	36	36	51
7/23/75	25	65	32	76	57	42	84	48	26	32	40	74
7/29/75	29	62	30	78	83	113	64	53	37	79	58	-
8/4/75	29	62	37	76	80	64	113	51	33	-	61	120
8/10/75	24	44	31	50	39	41	72	39	12	41	38	48

Table A.2 (continued). AIR QUALITY DATA FOR RENO

	Mamie Towles School	Reno Airport	Jessie Beck School	Cal-Neva Club	Health Dept.	Lake Tahoe	Sparks Nugget	Greenbrae School	Verdi School	Wadsworth	Nevada Fish & Game	Sewer Plant
8/16/75	34	52	-	65	64	61	93	52	24	27	37	61
8/22/75	20	37	21	16	59	22	78	32	11	16	41	48
8/28/75	14	36	-	53	46	28	56	27	10	18	35	50
9/3/75	41	55	41	58	63	26	79	61	30	47	61	84
9/9/75	33	35	32	47	51	20	58	35	26	34	40	48
9/15/75	34	65	36	21	58	19	47	36	19	25	44	63
9/21/75	34	50	30	38	59	22	91	27	30	68	47	75
9/27/75	42	53	49	66	78	37	88	56	38	-	59	77
Quarterly Geo. Mean	30	52	35	54	60	40	74	42	24	38	46	67
Yearly Geo. Mean	32	65	44	74	77	22	90	58	18	46	57	58

B. CHI SQUARE ANALYSIS

Table B.1. AIR QUALITY DATA FREQUENCY DISTRIBUTION AND CHI SQUARE ANALYSIS FOR LAS VEGAS

Date	Total No. of Samples	Samples per Fractile					χ^2	Region Wide Conc.
		1	2	3	4	5		
10/2/74	11				1	10	34.91*	H
10/8/74	11	3	5	2	1		6.73	
10/14/74	11	2	3	3	2	1	1.27	
10/20/74	8		1	2	2	3	3.25	
10/26/74	8	3	5				13.25*	
11/1/74	10	7	3				19.00*	L
11/7/74	8		2	3	2	1	3.25	
11/13/74	11				2	9	27.64*	H
11/20/74	11				5	6	16.73*	H
11/25/74	11			2	3	6	11.27*	
12/1/74	11		1	1	8	1	19.45*	
12/7/74	10	5	5				15.00*	L
12/13/74	9	1	3	4	1		5.50	
12/19/74	7			1	2	4	8.00	
12/25/74	6	6					24.00*	
12/31/74	9	9					36.00*	L
1/6/75	10		1	1	7	1	16.00*	
1/12/75	11	4	6			1	15.60*	
1/18/75	11			4	6	1	13.09*	
1/24/75	11				2	9	27.64*	H
1/30/75	11	6	1	4			13.09*	
2/5/75	10	8	2				24.00*	L
2/11/75	11		2	7	2		14.91*	
2/17/75	9	3	3	1	1	1	2.67	
2/23/75	9	2	3	4			7.11	
3/1/75	11		1	5	3	2	6.73	
3/7/75	11	2	4	5			9.45	
3/13/75	11	4	5	2			9.45	
3/19/75	10		5	3	1	1	8.00	
3/25/75	11				3	8	22.18*	H
3/31/75	11		1	1	7	2	13.64*	

Table B.1 (continued). AIR QUALITY DATA FREQUENCY DISTRIBUTION AND CHI SQUARE ANALYSIS FOR LAS VEGAS

Date	Total No. of Samples	Samples per Fractile					χ^2	Region Wide Conc.
		1	2	3	4	5		
4/6/75	11	11					44.00*	L
4/12/75	10	9	1				31.00*	L
4/18/75	11	10				1	34.91*	L
4/24/75	10		1	1	5	3	8.00	
4/30/75	11	3	4	3	1		4.91	
5/6/75	11	10	1				34.91*	L
5/12/75	9			2	4	3	7.11	
5/18/75	10	3	3	1	3		2.80	
5/24/75	9	3	5	1			10.44*	
5/30/75	11	3	4	2	1	1	3.09	
6/5/75	10		7	2		1	17.00*	
6/11/75	10	2	3	3	1	1	2.00	
6/17/75	11					11	44.00*	H
6/23/75	11			3	6	2	11.27*	
6/29/75	9	4	1	1	2	1	3.78	
7/5/75	10			3	4	3	7.00	
7/11/75	11			2	4	5	9.45	
7/17/75	10			6	1	3	13.00*	
7/23/75	10			6	3	1	13.00*	
7/29/75	11				4	7	18.55*	H
8/4/75	11			4	4	3	7.64	
8/10/75	11			3	6	2	8.27	
8/16/75	11	1	4	6			13.09*	
8/22/75	11	2	4	2	3		4.00	
8/28/75	11	1	4	4	1	1	4.91	
9/3/75	10			1	6	3	13.00*	
9/9/75	9	2	3	3	1		3.78	
9/15/75	10	2	2	5		1	7.00	
9/21/75	10	2	5	2		1	7.00	
9/27/75	11		1	7		3	15.82*	

* = Significant χ^2 value ($\chi^2 > 9.49$).
H = High Region-wide particulate concentrations.
L = Low Region-wide particulate concentrations.

Table B.2. AIR QUALITY DATA FREQUENCY DISTRIBUTION AND CHI SQUARE ANALYSIS FOR RENO

Date	Total No. of Samples	Samples per Fractile					χ^2	Region-Wide Conc.
		1	2	3	4	5		
10/2/74	7				1	6	19.43*	H
10/8/74	7		3	2	2		5.14	
10/14/74	8			1	5	2	10.75*	H
10/20/74	8					8	32.00*	H
10/26/74	8				6	2	17.00*	
11/1/74	8	7	1				23.25*	L
11/7/74	8			1	5	2	10.75*	H
11/13/74	8					8	32.00*	H
11/19/74	8			1	3	4	8.25	
11/25/74	7	2	3	2			5.14	
12/1/74	8			1	4	3	8.25	
12/7/74	8	4	1	2	1		5.75	
12/13/74	8		1	2	4	1	5.75	
12/19/74	7				2	5	14.86*	H
12/25/74	7			1	5	1	12.29*	
12/31/74	8				2	6	17.00*	H
1/6/75	8	8					32.00*	L
1/12/75	8			1		7	23.25*	H
1/18/75	8			1		7	23.25*	H
1/24/75	8				1	7	23.25*	H
1/30/75	8	1		1	3	3	4.50	
2/5/75	8	1	1	2	4		5.75	
2/11/75	7		1		1	5	12.29*	H
2/17/75	8		1	2	3	2	3.25	
2/23/75	8		1	1	6		15.75*	
3/1/75	8			2		6	17.00*	H
3/7/75	8	1	5	1	1		9.50*	
3/13/75	8	7		1			23.25*	L
3/19/75	8	5	2		1		10.75*	L
3/25/75	8	6	2				17.00*	L
3/31/75	8	3	4	1			8.25	

Table B.2 (continued). AIR QUALITY DATA FREQUENCY DISTRIBUTION AND CHI SQUARE ANALYSIS FOR RENO

Date	Total No. of Samples	Samples per Fractile					χ^2	Region-Wide Conc.
		1	2	3	4	5		
4/6/75	8	7		1			23.25*	L
4/12/75	8	1	5	2			10.75*	
4/18/75	8	2	6				17.00*	L
4/24/75	7		1	1	4	1	6.57	
4/30/75	8			2	5	1	10.75*	
5/6/75	8	1	6	1			15.75*	
5/12/75	8		3	3	2		5.75	
5/18/75	8	1	5	2			10.75*	
5/24/75	8		1	5	1	1	9.50*	
5/30/75	8			5	3		13.25*	
6/5/75	7			5	1	1	12.29*	
6/11/75	8			1	5	2	10.75*	
6/17/75	8		3	3		2	5.75	
6/23/75	7	2	1	1	3		5.75	
6/29/75	7	6	1				19.43*	L
7/5/75	7		5	1	1		12.29*	
7/11/75	8			3	4	1	8.25	
7/17/75	8	4	2	2			7.00	
7/23/75	8	1	3	3		1	4.50	
7/29/75	7		2	5			13.71*	
8/4/75	8		1	5	1	1	9.50*	
8/10/75	8	3	4	1			8.25	
8/16/75	7	1	2	3	1		3.71	
8/22/75	8	4	3	1			8.25	
8/28/75	7	6		1			19.43*	L
9/3/75	8		3	3	1	1	4.50	
9/9/75	8	6	1	1			15.75*	L
9/15/75	8	2	5		1		10.75*	L
9/21/75	8	1	4	2		1	5.75	
9/27/75	8		2	5		1	10.75*	

* - Significant χ^2 value ($\chi^2 > 9.49$).

H - High Region-wide particulate concentrations.

L - Low Region-wide particulate concentrations.

C. MICROINVENTORIES

Table C.1. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Las Vegas Airport

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	8.0 acre-months	1.0 ton/ac/mo	8.4[a]
Cleared areas	39.0 acres	0.94-2.75 ton/ac/mo[b]	76.0
Unpaved roads	40 VMT/day	5.3 lb/VMT	38.7
Normal paved roads	65,952 VMT/day	1.75 gm/VMT (14 gm/VMT)[c]	42.1 (336.8)
Unpaved parking lots	690 VMT/yr	1.8 lb/VMT	0.6
R.R. right of ways and yards	2.1 acres	0.9 ton/ac/yr	1.9
Stationary area source fuel combustion			Negligible
Motor vehicles	65,952 VMT/day	0.0013 lb/VMT	15.6
Railroads	688 gal/yr	0.025 lb/gal	Negligible
Airport			43.6
Total			226.9 (521.6)
Emission density, ton/mi^2/yr			72.22 (166)
Percent fugitive dust			73.9 (88.6%)

[a] Included are cleared area emissions for time period other than active construction.
[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.
[c] Based on recently developed and as yet unpublished data.

Table C.2. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Basic School (Henderson)

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	118 acres	0.64 ton/ac/yr	75.5
Playground	2 acres	2.5 ton/ac/yr	5.0
Unpaved roads	85 VMT/day	5.3 lb/VMT	82.2
Normal paved roads	26,550 VMT/day	1.75 gm/VMT (14 gm/VMT)[a]	16.9 (135.2)
Unpaved parking lots	414 VMT/yr plus 1.7 acres	1.8 lb/VMT 0.74 ton/ac/yr	1.7
R.R. right of ways and yards	2.0 acres	0.9 ton/ac/yr	1.8
Stationary area source fuel combustion			Negligible
Motor vehicles	26,550 VMT/day	0.0013 lb/VMT	5.7
Railroads	382 gal/yr	0.025 lb/gal	Negligible
Point source			208.0
Total			396.8 (515.1)
Emission density, ton/mi^2/yr			126.3 (163.9)
Percent fugitive dust			46.14 (58.5%)

[a] Based on recently developed and as yet unpublished data.

Table C.3. MICROINVENTORY OF PARTICULATE EMISSIONS
CLARK COUNTY, NEVADA

Location: Clark County Health Dept.

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	228.2 acres	0.41-2.06 ton/ac/yr[a]	208.9
Unpaved roads	134 VMT/day	5.3 lb/VMT	129.9
Normal paved roads	302,080 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	193.1 (1544.8)
Unpaved parking lots	2898 VMT/yr plus 0.25 acres	1.8 lb/VMT 0.74 ton/ac/yr	2.8
R.R. right of ways and yards	137 acres	0.9 ton/ac/yr	123.3
Heavy equipment storage	2.2 acres	1.34 ton/ac/yr	3.0
Stationary area source fuel combustion			Negligible
Motor vehicles	302,080 VMT/day	0.0013 lb/VMT	71.6
Railroads	121,641 gal/yr	0.025 lb/gal	1.3
Point source			7.0
Total			740.9 (2092.6)
Emission density, ton/mi^2/yr			235.83 (666)
Percent fugitive dust			89.21 (96.2%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Based on recently developed and as yet unpublished data.

Table C.4. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Henderson Post Office

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	8.4 acres	2.16-2.40 ton/ac/yr[a]	19.2
Unpaved roads	209.5 VMT/day	5.3 lb/VMT	202.6
Normal paved roads	66,066 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	42.2 (337.6)
Sand and gravel pits	12.3 acres active	3.4 ton/ac/yr	41.8
Unpaved parking lots	3.7 acres	0.74 ton/ac/yr	2.7
Heavy equipment storage	8.0 acres	1.34 ton/ac/yr	10.7
Stationary area source fuel combustion			Negligible
Motor vehicles	66,066 VMT/day	0.0013 lb/VMT	15.7
Point source			180.0
Total			514.9 (810.3)
Emission density, ton/mi^2/yr			163.89 (257.9)
Percent fugitive dust			61.99 (75.8%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Based on recently developed and as yet unpublished data.

Table C.5. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Las Vegas Fire Dept. No. 1

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	136.3 acres	0.40-0.82 ton/ac/yr[a]	71.7
Unpaved roads	139.4 VMT/day	5.3 lb/VMT	134.7
Normal paved roads	243,884 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	155.9 (1247.2)
Aggregate storage	3.3 acres	3.4 ton/ac/yr	11.2
Unpaved parking lots	1.13 acres	0.74 ton/ac/yr	0.9
R.R. right of ways and yards	137 acres	0.9 ton/ac/yr	123.3
Heavy equipment storage	7.3 acres	1.34 ton/ac/yr	9.8
Stationary area source fuel combustion			Negligible
Motor vehicles	243,884 VMT/day	0.0013 lb/VMT	57.9
Railroads	142,350 gal/yr	0.025 lb/gal	1.8
Point source			5.0
Total			572.2 (1663.5)
Emission density, ton/mi^2/yr			182.13 (529.5)
Percent fugitive dust			89.56 (96.1%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Based on recently developed and as yet unpublished data.

Table C.6. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Las Vegas Fire Dept. No. 2

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	96.6 acres	0.18-2.29 ton/ac/yr[a]	102.0
Unpaved roads	60 VMT/day	1.06-5.3 lb/VMT[b]	38.7
Normal paved roads	125,814 VMT/day	1.75 gm/VMT (14 gm/VMT)[c]	80.4 (643.2)
Unpaved parking lots	4.0 acres	0.74 ton/ac/yr	3.0
Horse corral and stable	4.1 acres	3.0 ton/ac/yr	12.3
Motor vehicles	125,814 VMT/day	0.0013 lb/VMT	29.8
Total			266.2 (829.0)
Emission density, ton/mi^2/yr			84.73 (263.8)
Percent fugitive dust			88.8 (96.4%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Range of emission factors used. Factors vary by vehicle speed.

[c] Based on recently developed and as yet unpublished data.

Table C.7. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Nellis Air Force Base

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	19.2 acre-months	1.0 ton/ac/mo	21.1[a]
Cleared areas	16.5 acres	1.09 ton/ac/yr	18.0
Normal paved roads	43,771 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	27.9 (223.2)
Aggregate storage	1.4 acres inactive, 9 months	1.14 ton/ac/yr	1.6[c]
Unpaved parking lots	138 VMT/yr	1.8 lb/VMT	0.1
Stationary area source fuel combustion			Negligible
Motor vehicles	43,771 VMT/day	0.0013 lb/VMT	10.4
Aircraft			5.8
Total			84.9 (280.2)
Emission density, ton/mi^2/yr			27.02 (89.2)
Percent fugitive dust			80.91 (94.28)

[a] Included are cleared area emissions for time period other than active construction.

[b] Based on recently developed and as yet unpublished data.

[c] Included are cleared area emissions for time period other than aggregate storage.

Table C.8. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: North Las Vegas

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	1.5 acre-months	1.0 ton/ac/mo	1.9[a]
Cleared areas	71.6 acres	0.64-1.14 ton/ac/yr[b]	79.6
Unpaved roads	85.5 VMT/day	4.4-5.3 lb/VMT[c]	72.9
Normal paved roads	169,072 VMT/day	1.75 gm/VMT (14 gm/VMT)[d]	108.0 (864)
Unpaved parking lots	2.8 acres	0.74 ton/ac/yr	2.1
R.R. right of ways	1.8 acres	0.9 ton/ac/yr	1.6
Stationary area source fuel combustion			Negligible
Motor vehicles	169,072 VMT/day	0.0013 lb/VMT	40.1
Railroads	44,968 gal/yr	0.025 lb/gal	0.6
Total			306.8 (1062.8)
Emission density, ton/mi^2/yr			97.65 (338.3)
Percent fugitive dust			86.73 (96.2%)

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Range of emission factors used. Factors vary by vehicle speed.

[d] Based on recently developed and as yet unpublished data.

Table C.9. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Sahara Hotel

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	88 acre-months	1.0 ton/ac/mo	92.0[a]
Cleared areas	179.2 acres	0.44-1.34 ton/ac/yr[b]	142.9
Unpaved roads	32 VMT/day	5.3 lb/VMT	31.0
Normal paved roads	273,668 VMT/day	1.75 gm/VMT (14 gm/VMT)[c]	174.9 (1399.2)
Unpaved parking lots	12,143 VMT/yr plus 4.25 acres	1.8 lb/VMT 0.74 ton/ac/yr	14.0
R.R. right of ways	4.1 acres	0.9 ton/ac/yr	3.7
Heavy equipment storage	7.5 acres	1.34 ton/ac/yr	10.1
Dirty paved roads	28,410 VMT/day	28 gm/VMT	319.7
Stationary area source fuel combustion			Negligible
Motor vehicles	317,946 VMT/day	0.0013 lb/VMT	75.4
Railroads	51,392 gal/yr	0.025 lb/gal	0.6
Point source			7.0
Total			871.3 (2095.6)
Emission density, ton/mi^2/yr			277.34 (667)
Percent fugitive dust			90.47 (96%)

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Based on recently developed and as yet unpublished data.

Table C.10. MICROINVENTORY OF PARTICULATE EMISSIONS
CLARK COUNTY, NEVADA

Location: Las Vegas Stadium

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	1.8 acre-months	1.0 ton/ac/mo	2.3[a]
Unpaved roads	15 VMT/day	5.3 lb/VMT	14.5
Normal paved roads	38,431 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	24.6 (196.8)
Sand and gravel pits	4 acres active 40 acres inactive	3.4 ton/ac/yr 1.14 ton/ac/yr	59.2
Unpaved parking lots	13.0 acres	0.74 ton/ac/yr	9.6
Stationary area source fuel combustion			Negligible
Motor vehicles	38,431 VMT/day	0.0013 lb/VMT	9.1
Total			119.3 (291.5)
Emission density, ton/mi^2/yr			37.97 (92.7)
Percent fugitive dust			92.37 (96.8%)

[a] Included are cleared area emissions for time period other than active construction.

[b] Based on recently developed and as yet unpublished data.

Table C.11. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Sunrise Power Plant

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	6.1 acres	1.14-1.28 ton/ac/yr[a]	7.4
Normal paved roads	400 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	0.2 (1.6)
Sand and gravel pits	19.7 acres active 1.4 acres inactive	3.4 ton/ac/yr 1.4 ton/ac/yr	68.6
Unpaved parking lots	415 VMT/yr	1.8 lb/VMT	0.4
Agriculture	23 acres	tilling 0.49 ton/ac/yr windblown 0.11 ton/ac/yr	13.8
Stationary area source fuel combustion			Negligible
Motor vehicles	400 VMT/day	0.0013 lb/VMT	0.1
Point source			14.0
Power plant			144.0
Total			248.5 (249.9)
Emission density, ton/mi^2/yr			79.1 (79.5)
Percent fugitive dust			36.37 (36.7%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Based on recently developed and as yet unpublished data.

Table C.12. MICROINVENTORY OF PARTICULATE EMISSIONS CLARK COUNTY, NEVADA

Location: Las Vegas Wash

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Normal paved roads	3,012 VMT/day	1.75 gm/VMT (14 gm/VMT)[a]	1.9 (15.2)
Unpaved parking lots	16 acres	0.148-0.74 ton/ac/yr[b]	3.5
Stationary area source fuel combustion			Negligible
Motor vehicles	3,012 VMT/day	0.0013 lb/VMT	0.7
Total			6.1 (19.4)
Emission density, ton/mi^2/yr			1.94 (6.2)
Percent fugitive dust			88.52 (96.4%)

[a] Based on recently developed and as yet unpublished data.

[b] Range of emission used. Factors vary by surface stabilization.

Table C.13. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Washoe County Health Dept.

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	9.8 acres	0.18-0.82 ton/ac/yr[a]	2.5
Playground	1.7 acres	1.5 ton/ac/yr	2.6
Unpaved roads	333 VMT/day	3.1-4.7 lb/VMT[b]	198.8
Normal paved roads	428,101 VMT/day	1.75 gm/VMT (14 gm/VMT)[c]	242.3 (1938.4)
Sand and gravel pits	60.0 acres	1.9 ton/ac/yr	114.0
Unpaved parking lots	1.9 VMT/day	1.6 lb/VMT	0.6
R.R. right of ways and yards	10.4 acres	0.2 ton/ac/yr	2.0
Heavy equipment storage	6.6 acres	0.32 ton/ac/yr	2.1
Agriculture	16.3 acres	windblown 5.36 lb/ac/yr tilling 280.0 lb/ac/yr	2.4
Sand on streets for snow control			21.6
Stationary area source fuel combustion			52.5
Fireplaces			26.7
Motor vehicles	428,101 VMT/day	0.00013 lb/VMT	101.6
Railroads	187,183 gal/yr	0.025 lb/gal	2.3
Point source			19.0

Table C.13 (continued). MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Washoe County Health Dept.

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Total			791 (2487.1)
Emission density, ton/mi^2/yr			251.78 (617)
Percent fugitive dust			76.85 (92.6%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Range of emission factors used. Factors vary by vehicle speed.

[c] Based on recently developed and as yet unpublished data.

Table C.14. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Cal-Neva Club

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	2.6 acres	0.2-0.3 ton/ac/yr[a]	0.7
Unpaved roads	8.0 VMT/day	3.9 lb/VMT	5.7
Normal paved roads	452,233 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	255.9 (2047.2)
Unpaved parking lots	1.5 VMT/day	1.6 lb/VMT	0.4
R.R. right of ways and yards	10.4 acres	0.2 ton/ac/yr	2.0
Agriculture	16.3 acres	windblown 5.36 lb/ac/yr tilling 280 lb/ac/yr	2.3
Sand on streets for snow control			22.8
Stationary area source fuel combustion			52.5
Fireplaces			26.7
Motor vehicles	452,233 VMT/day	0.0013 lb/VMT	107.3
Railroads	189,690 gal/yr	0.025 lb/gal	2.4
Point source			
Total			478.7 (2270)
Emission density, ton/mi^2/yr			152.37 (722.6)
Percent fugitive dust			60.53 (91.7%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Based on recently developed and as yet unpublished data.

Table C.15. MICROINVENTORY OF PARTICULATE EMISSIONS
WASHOE COUNTY, NEVADA

Location: Jessie Beck School

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Playground	8.5 acres	1.5 ton/ac/yr	12.8
Normal paved roads	112,852 VMT/day	1.75 gm/VMT (14 gm/VMT)[a]	63.9 (511.2)
Unpaved road shoulders	7.0 VMT/day	1.6 lb/VMT	0.3
Unpaved parking lots	1.5 VMT/day 4.1 acres	1.6 lb/VMT 0.65 ton/ac/yr	 3.1
Sand on streets for snow control			5.7
Stationary area source fuel combustion			8.1
Fireplaces			43.6
Motor vehicles	112,852 VMT/day	0.0013 lb/VMT	26.7
Total			164.2 (611.5)
Emission density, ton/mi^2/yr			52.26 (194.6)
Percent fugitive dust			52.25 (86.2%)

[a] Based on recently developed and as yet unpublished data.

Table C.16. MICROINVENTORY OF PARTICULATE EMISSIONS
WASHOE COUNTY, NEVADA

Location: Reno Airport

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Cleared areas	54.1 acres	0.05-0.24 ton/ac/yr[a]	8.1
Playground	2.6 acres	1.5 ton/ac/yr	3.9
Unpaved roads	12.5 VMT/day	3.9 lb/VMT	8.9
Normal paved roads	77,830 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	44.0 (352)
Sand and gravel pits	46.7 acres	0.64 ton/ac/yr	29.9
Unpaved parking lots	1.9 acres	0.65 ton/ac/yr	1.2
Heavy equipment storage	1.4 acres	0.32 ton/ac/yr	0.5
Stationary area source fuel combustion			11.6
Fireplaces			0.1
Motor vehicles	77,830 VMT/day	0.0013 lb/VMT	18.5
Airport			7.1
Total			133.8 (441.8)
Emission density, ton/mi^2/yr			42.58 (140.6)
Percent fugitive dust			72.12 (91.5%)

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Based on recently developed and as yet unpublished data.

Table C.17. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Nevada Fish & Game

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	77.6 acre-months	1.0 ton/ac/mo	78.4[a]
Cleared areas	10.9 acres	0.18-0.2 ton/ac/yr[b]	2.0
Playground	2.6 acres	1.5 ton/ac/yr	3.9
Unpaved roads	118 VMT/day	2.4-3.9 lb/VMT[c]	67.2
Normal paved roads	347,166 VMT/day	1.75 gm/VMT (14 gm/VMT)[d]	196.5 (1572)
Unpaved road shoulders	8 VMT/day	1.6 lb/VMT	2.3
R.R. right of ways and yards	10.4 acres	0.2 ton/ac/yr	2.0
Agriculture	16.3 acres	windblown 5.36 lb/ac/yr tilling 280.0 lb/ac/yr	2.3
Horse corral and stable	3.1 acres	3.0 ton/ac/yr	9.3
Sand on streets for snow control			17.5
Stationary area source fuel combustion			28.1
Fireplaces			7.6
Motor vehicles	347,166 VMT/day	0.0013 lb/VMT	82.4
Railroads	152,058 gal/yr	0.025 lb/gal	1.9
Point source			2.0

Table C.17 (continued). MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Nevada Fish & Game

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Total			503.4 (1878.9)
Emission density, ton/mi^2/yr			160.23 (598)
Percent fugitive dust			75.76 (93.5%)

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Range of emission factors used. Factors vary by vehicle speed.

[d] Based on recently developed and as yet unpublished data.

Table C.18. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Mamie Towles School

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	67.2 acre-months	1.0 ton/ac/mo	68.7[a]
Cleared areas	76.9 acres	0.03-0.13 ton/ac/yr[b]	4.8
Playground	7.1 acres	1.5 ton/ac/yr	10.7
Unpaved roads	12.5 VMT/day	3.9-4.7 lb/VMT[c]	9.2
Normal paved roads	46,481 VMT/day	1.75 gm/VMT (14 gm/VMT)[d]	26.3 (210.4)
Sand on streets for snow control			2.3
Stationary area source fuel combustion			14.9
Fireplaces			127.6
Motor vehicles	46,481 VMT/day	0.0013 lb/VMT	11.0
Total			275.5 (459.6)
Emission density, ton/mi^2/yr			87.69 (146.29
Percent fugitive dust			44.28 (66.6%)

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Range of emission factors used. Factors vary by vehicle speed.

[d] Based on recently developed and as yet unpublished data.

Table C.19. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Greenbrae School

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	31.4 acre-months	1.0 ton/ac/mo	32.2[a]
Cleared areas	12.2 acres	0.18-0.24 ton/ac/yr[b]	2.3
Playground	5.9 acres	1.5 ton/ac/yr	8.9
Unpaved roads	40 VMT/day	3.9 lb/VMT	28.5
Normal paved roads	79,592 VMT/day	1.75 gm/VMT (14 gm/VMT)[c]	45.0 (360)
Stationary area source fuel combustion			25.9
Fireplaces			56.7
Motor vehicles	79,592 VMT/day	0.0013 lb/VMT	15.2
Total			214.7 (529.7)
Emission density, ton/mi^2/yr			68.34 (168.6)
Percent fugitive dust			54.44(81.5%)

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Based on recently developed and as yet unpublished data.

Table C.20. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Sparks Nugget

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	22.4 acre-months	1.0 ton/ac/mo	22.6[a]
Cleared areas	4.4 acres	0.2-0.24 ton/ac/yr[b]	1.0
Playground	4.8 acres	1.5 ton/ac/yr	7.2
Unpaved roads	40 VMT/day	3.9 lb/VMT	28.5
Normal paved roads	149,083 VMT/day	1.75 gm/VMT (14 gm/VMT)[c]	84.4 (675.2)
Unpaved parking lots	4.5 acres	0.65 ton/ac/yr	3.0
R.R. right of ways and yards	84.2 acres	0.2 ton/ac/yr	16.8
Heavy equipment storage	2.2 acres	0.32 ton/ac/yr	0.7
Dirty paved roads	2,266 VMT/day	28 gm/VMT	20.5
Stationary area source fuel combustion			25.2
Fireplaces			37.0
Motor vehicles	151,349 VMT/day	0.0013 lb/VMT	35.9
Railroads	256,266 gal/yr	0.025 lb/gal	3.2
Point source			0.2
Total			310.0 (902.0)
Emission density, ton/mi^2/yr			98.7 (287.1)
Percent fugitive dust			67.3 (88.7)

[a] Included are cleared area emissions for time period other than acitive construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Based on recently developed and as yet unpublished data.

Table C.21. MICROINVENTORY OF PARTICULATE EMISSIONS
WASHOE COUNTY, NEVADA

Location: Lake Tahoe

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	6.4 acre-month	1.0 ton/ac/mo	6.4[a]
Cleared areas	0.5 acre	0.23 ton/ac/yr	0.1
Unpaved roads	1.1 VMT/day	3.1 lb/VMT	0.6
Normal paved roads	21,801 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	12.3 (98.4)
Unpaved parking lots	1.3 acres	0.65 ton/ac/yr	0.3
Stationary area source fuel combustion			1.9
Fireplaces			24.5
Motor vehicles	21,801 VMT/day	0.0013 lb/VMT	5.2
Total			51.3 (137.4)
Emission density, ton/mi^2/yr			16.33 (43.73)
Percent fugitive dust			38.4 (77%)

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[a] Included are cleared area emissions for time period other than active construction.

[b] Based on recently developed and as yet unpublished data.

Table C.22. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Verdi School

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Playground	2.5 acres	1.5 ton/ac/yr	3.8
Unpaved roads	15.0 VMT/day	2.35-4.70 lb/VMT[a]	11.1
Normal paved roads	15,496 VMT/day	1.75 gm/VMT (14 gm/VMT)[b]	8.8 (70.4)
Unpaved road shoulders	0.6 VMT/day	1.6 lb/VMT	0.2
Unpaved parking lots	0.2 acres	0.65 ton/ac/yr	0.1
Stationary area source fuel combustion			1.8
Motor vehicles	15,496 VMT/day	0.0013 lb/VMT	3.7
Railroads	155,436 gal/yr	0.025 lb/gal	1.9
Total			32 (93.6)
Emission density, ton/mi^2/yr			10.18 (29.79
Percent fugitive dust			76.87 (92.1

[a] Range of emission factors used. Factors vary by vehicle speed.
[b] Based on recently developed and as yet unpublished data.

Table C.23. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Wadsworth Fire Dept.

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Playground	3.1 acres	1.5 ton/ac/yr	4.7
Normal paved roads	2731 VMT/day	1.75 gm/VMT (14 gm/VMT)[a]	1.5 (12)
Sand and gravel pits	5.0 acres	0.64 ton/ac/yr	3.2
Unpaved parking lots	0.14 acres	0.65 ton/ac/yr	0.1
R.R. right of ways and yards	2.9 acres	0.2 ton/ac/yr	0.6
Stationary area source fuel combustion			Negligible
Motor vehicles	2731 VMT/day	0.0013 lb/VMT	0.5
Railroads	56,560 gal/yr	0.025 lb/gal	0.7
Total			11.3 (21.8)
Emission density, ton/mi^2/yr			3.59 (6.9)
Percent fugitive dust			89.38 (94.5%)

[a] Based on recently developed and as yet unpublished data.

Table C.24. MICROINVENTORY OF PARTICULATE EMISSIONS WASHOE COUNTY, NEVADA

Location: Sewer Plant

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr
Active construction	7.2 acre-months	1.0 ton/ac/mo	7.3[a]
Unpaved roads	52.1 VMT/day	3.1-3.9 lb/VMT[b]	32.3
Normal paved roads	8,948 VMT/day	1.75 gm/VMT (14 gm/VMT)[c]	5.1 (40.8)
Aggregate storage	0.2 acres	1.9 ton/ac/yr	0.4
Unpaved parking lots	1.1 acres	0.65 ton/ac/yr	0.7
R.R. right of way	3.2 acres	0.2 ton/ac/yr	0.6
Agriculture	13.4 acres	windblown 1320 lb/ac/yr tilling 280 lb/ac/yr	10.6
Stationary area source fuel combustion			1.9
Fireplaces			0.2
Motor vehicles	8,948 VMT/day	0.0013 lb/VMT	2.1
Railroads	101,836 gal/yr	0.025 lb/gal	1.3
Point source			14.0
Total			76.5 (112.2)
Emission density, ton/mi^2/yr			24.35 (35.71)
Percent fugitive dust			74.5 (95.09%)

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by vehicle speed.

[c] Based on recently developed and as yet unpublished data.

D. EMISSION DENSITY VERSUS AIR QUALITY

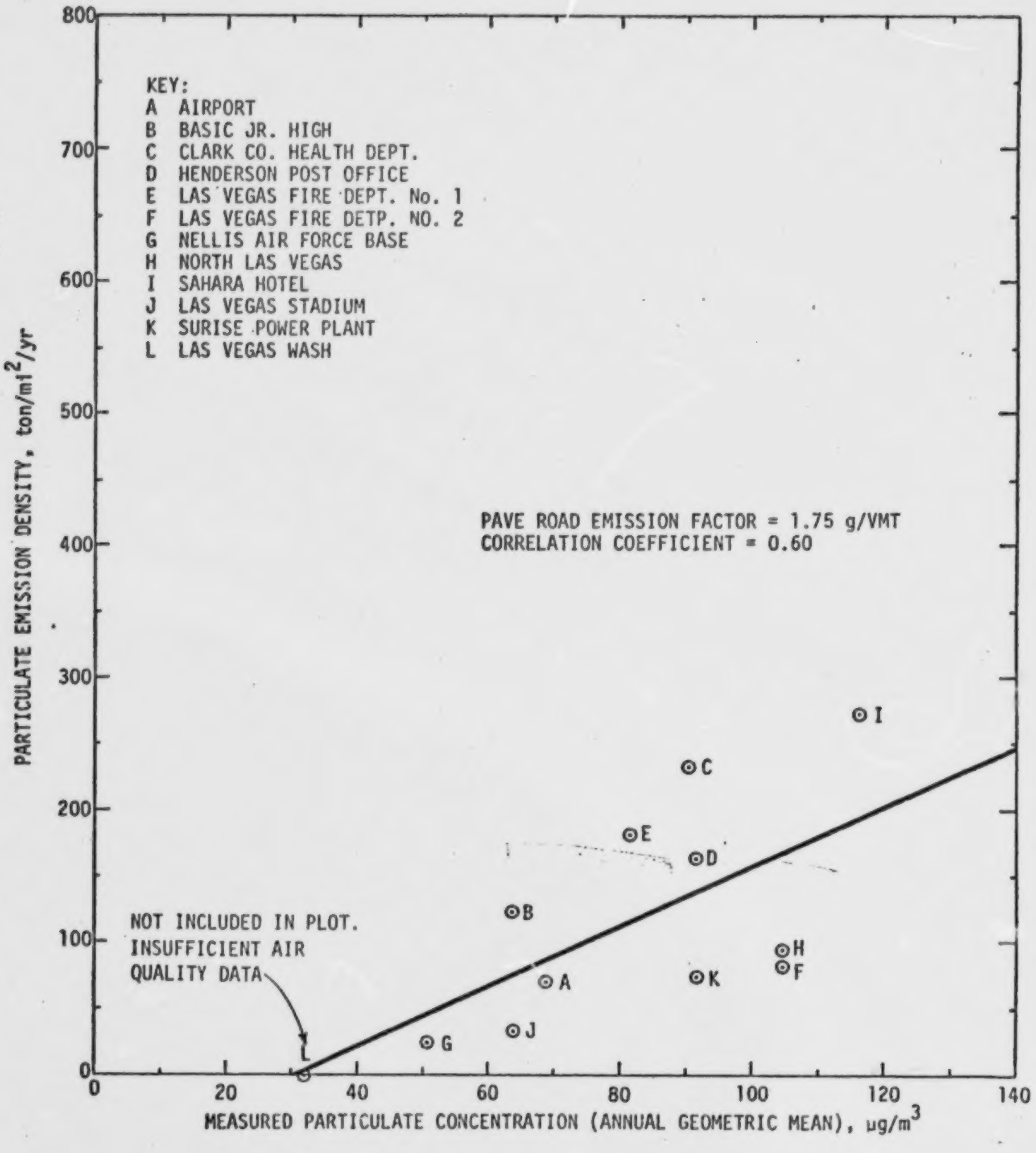

Figure D.1. Emision density vs. air quality - Las Vegas.

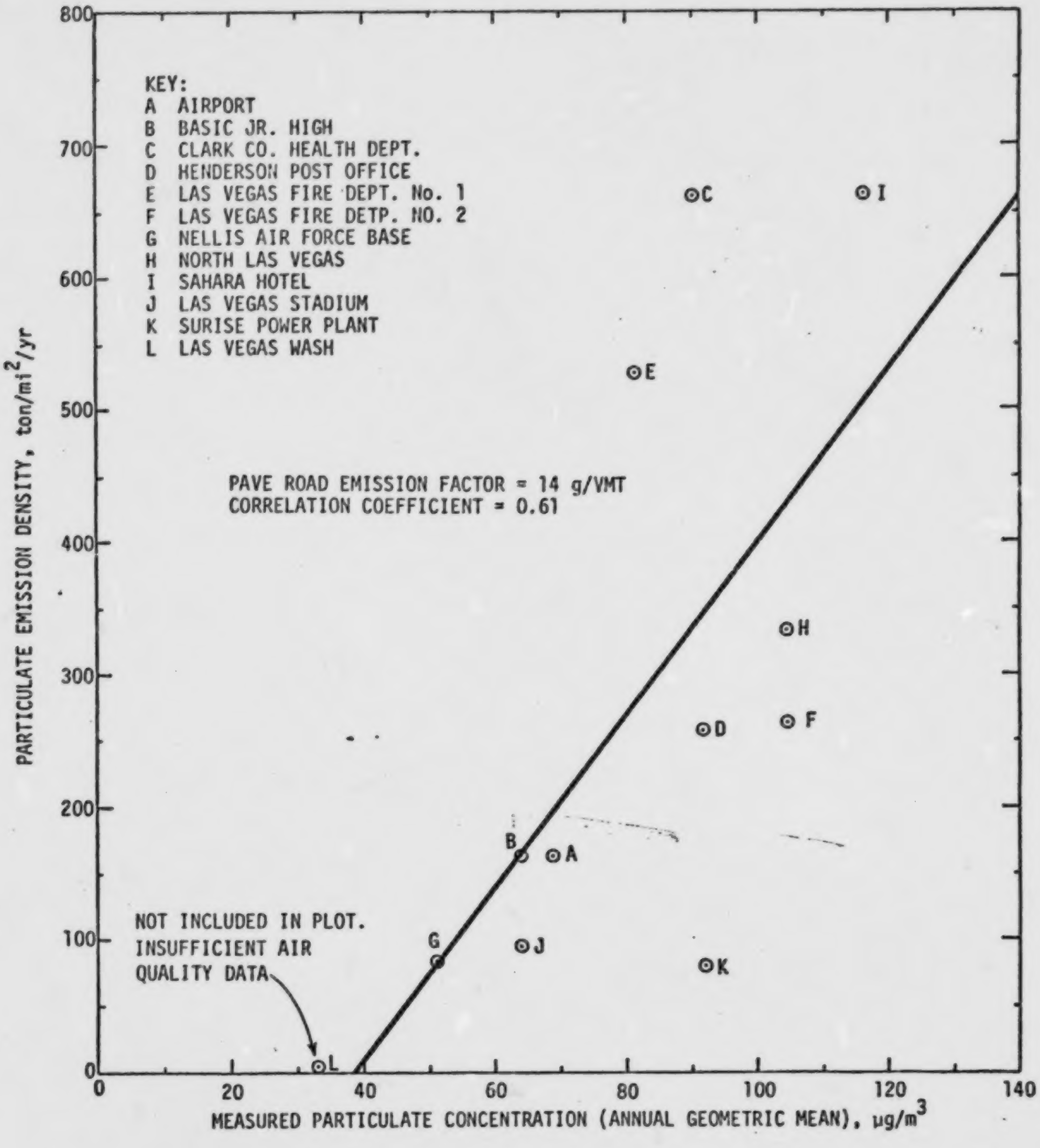

Figure D.2. Emission density vs. air quality - Las Vegas.

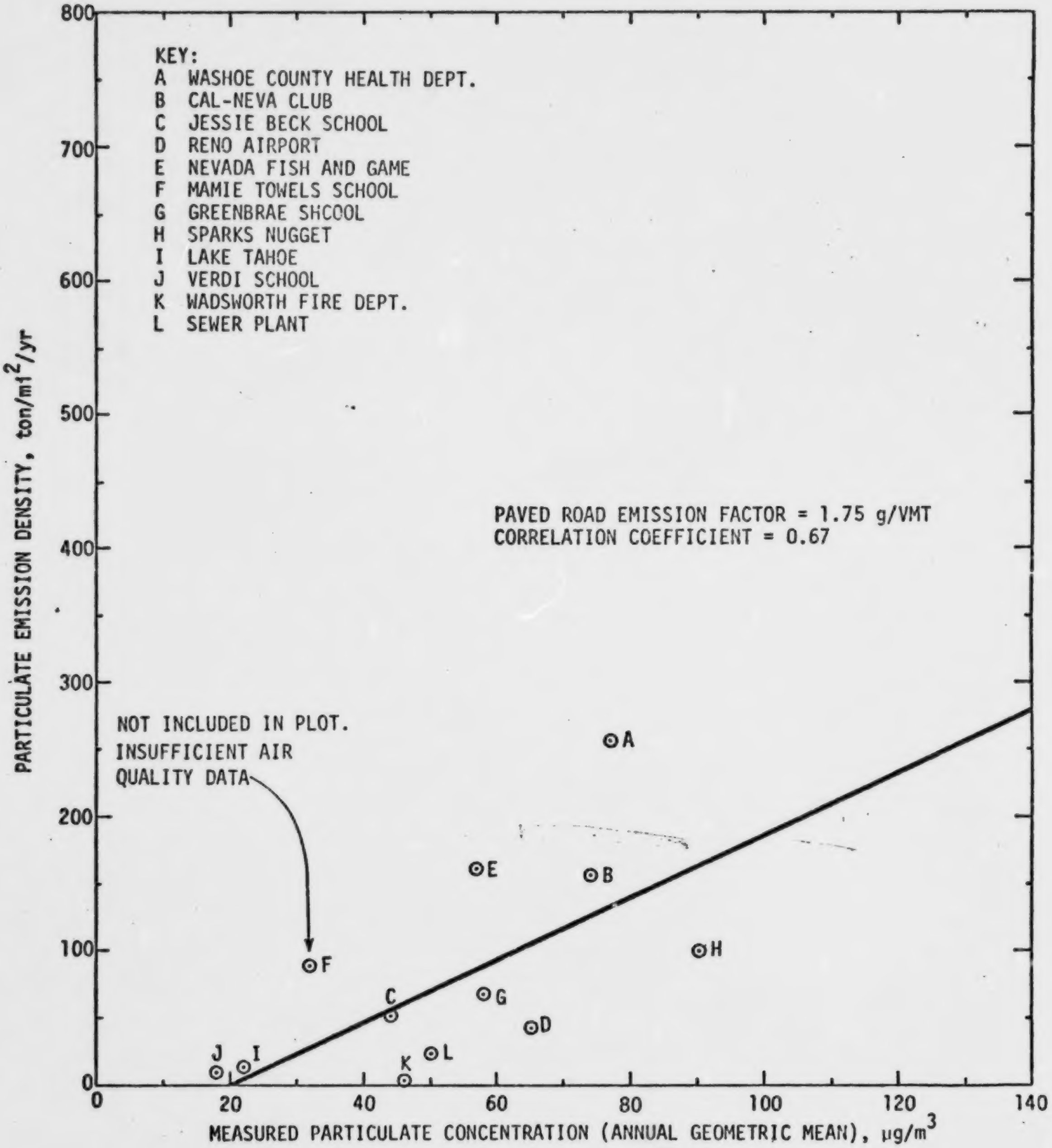

Figure D.3. Emission density vs. air quality - Reno.

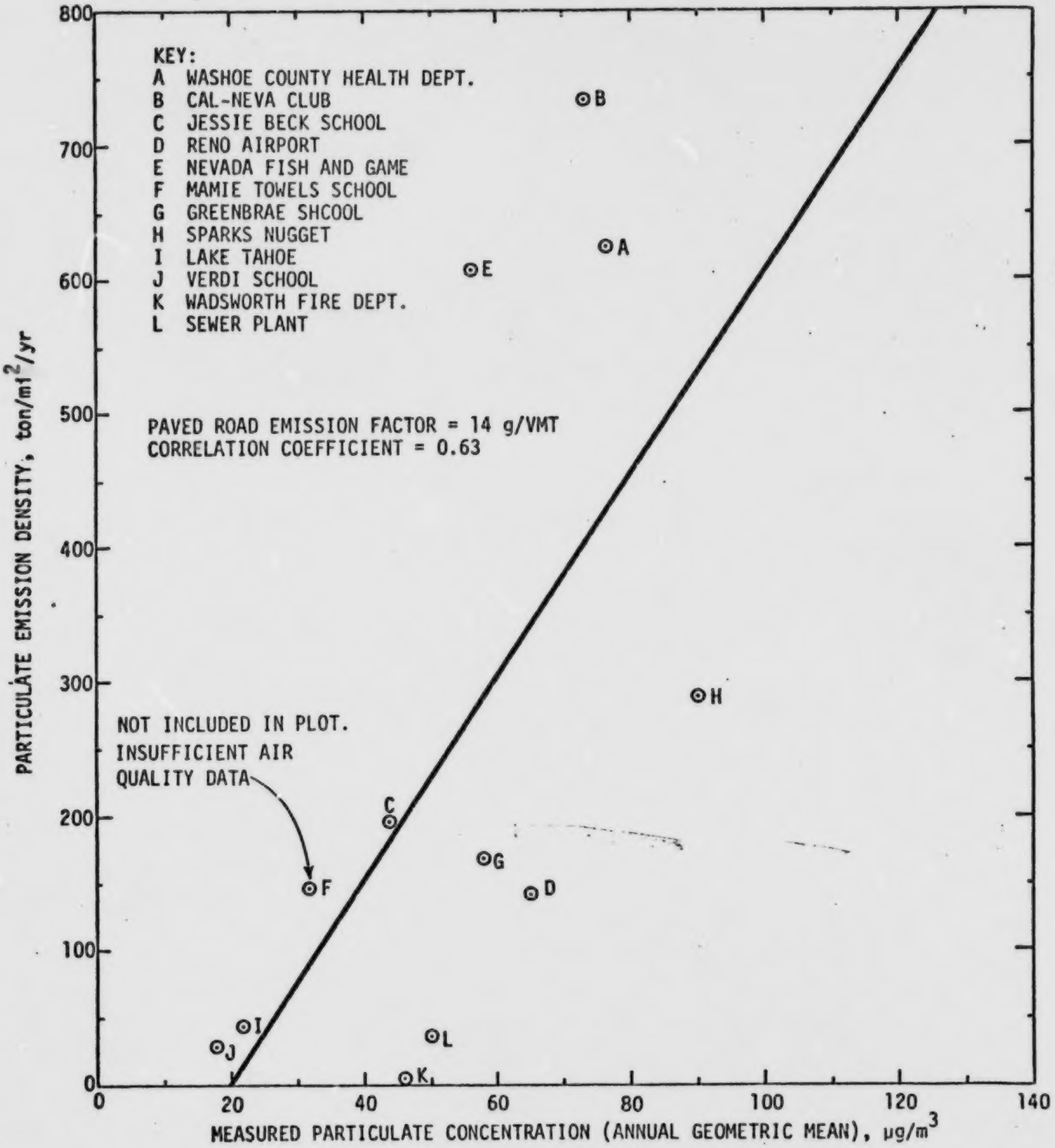

Figure D.4. Emission density vs. air quality - Reno.

TASK B REPORT*
FACTORS INFLUENCING EMISSIONS FROM FUGITIVE SOURCES

1. INTRODUCTION

This task report is intended to describe the development of emission factors for all fugitive dust source categories identified in the two Nevada study areas. The final emission factors include: (1) estimates of emission rates by particle size range and (2) correction functions for variations from the average emission rates.

Fugitive dust categories were determined during field surveys of the study areas (microinventories), from discussions with project participants in the state and county control agencies, from the categories listed in the scope of work for the contract, and from prior investigations of fugitive dust in other areas of the U.S. The twelve major source categories and some of the subcategories identified are shown in Table 1.1.

Table 1.1 also lists two categories of naturally occurring dust sources that are subject to seasonal and locational emission variation due to the same factors (such as soil type, windspeed, precipitation, and vegetative cover) which influence fugitive dust emission rates. No emission factors per se were prepared for the naturally occurring dust sources, since they are considered to be components of the background concentration. The calculation of background concentrations throughout the two study areas, including estimation of the influence of local soil type on these concentrations, will be presented in the Task D report, Emission Diffusion.

For the present task, all available emission factors and particle size distribution data for the 12 fugitive dust source categories were assembled and new factors were

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Table 1.1 FUGITIVE DUST SOURCE CATEGORIES IN NEVADA STUDY AREAS

- Cleared areas
    - (includes fairgrounds and corrals)
- Active construction
    - Building construction
    - Highway construction
- Sand and gravel pits
    - Aggregate storage
    - Crushing and sizing
- Equipment storage areas
- Playgrounds and athletic fields
- Reintrained dust from paved streets
    - Normal streets
    - Commercial (dirty) streets
- Street sanding for snow control
- Unpaved roads
- Unpaved parking lots
- Road shoulders
- Railroad right-of-ways and yards
- Agriculture
    - Tilling operations
    - Wind erosion
- Naturally occurring dust sources
    - Undamaged native surfaces
    - Native surfaces with soil disturbed

developed where necessary. This research is reported in Chapters 2 and 3. Then, parameters which significantly affect emission rates from these sources were identified, and data to quantify the seasonal and locational variations in emission rate caused by each of these parameters were collected. This work is reported in Chapter 4. All these results are brought together in Chapter 5, which summarizes the corrected emission factors by particle size for each fugitive dust source category.

2. DEVELOPMENT OF EMISSION FACTORS

CLEARED AREAS

An adaptation of the U.S. Department of Agriculture's wind erosion equation[1,2,3] was used as the basis for deriving emission factors for cleared areas. The modified equation estimates annual suspended particulate emissions due to wind erosion from exposed soil surfaces:

$$E = a\ I\ K\ C\ L'\ V' \qquad \text{(eq.1)}$$

where E = emission factor, ton/acre/yr
a = portion of total wind erosion losses that would be measured as suspended particulate
I = soil erodibility, ton/acre/yr
K = surface roughness factor
C = climatic factor
L' = unsheltered field width factor
V' = vegetative cover factor

In this equation, K, C, L', and V' are all dimensionless. Climatic factors for Las Vegas and Reno are 1.27 and 0.30, respectively. Their derivations are explained in detail in Chapter 4 of this report. The cleared areas are generally left with a fairly smooth surface, which is equivalent to a K value of 1.0. An average field width of 1000 ft was assumed for all the cleared areas, since this is not a critical variable in the equation. The L' values equivalent to L = 1000 ft were determined from a nomograph in which soil type is also a variable.[3]

The remaining variables in the wind erosion equation--a, I, and V'--are functions of the soil type and ground cover on each cleared area. In performing the field survey work, the following descriptors were used for soil type and vegetation:

Soil type
- Rocky
- Demolition waste
- Sandy
- Fine
- Clay loam

Vegetation
- None
- Sparse
- Moderate
- Heavy

Values of a, I, and V (in lb/acre of air-dried residue) corresponding to the above descriptions were obtained from USDA publications on wind erosion,[2,4] and are summarized below:

Soil type	a	I, ton/acre/yr
Rocky, demolition waste	0.025	38
Sandy	0.010	134
Fine	0.041	52
Clay loam	0.025	47

Vegetative cover	V, lb/acre
None	0
Sparse	250
Moderate	500
Heavy	1000

Using the above input data, emission factors were calculated for all soil type and vegetation conditions on cleared areas in the two study areas. These emission factors are presented in Table 2.1.

Two minor source categories, fairgrounds and corrals, were grouped with cleared areas because of similarities. An emission factor previously developed[5] for cattle feedlots was thought to be appropriate for corrals--3 ton/acre/yr.

For fairgrounds, the bare soil areas are indistinguishable from other cleared areas for most of the year. During fairs, the parking area can be considered an unpaved parking lot. Additional information on attendance and duration of the fairs are required to estimate vehicle-miles of travel (VMT). Other activities on the fairgrounds (exhibition area, races, carnival area) probably produce negligible emissions.

ACTIVE CONSTRUCTION

The emission factor recommended for use in Las Vegas was derived directly from sampling at a construction site in that city in 1972.[5] The value of 1.0 ton/acre/month is appropriate for residential and commercial construction with excavation and regrading, and includes the effect on emission reduction of moderate watering of the site. Although no sampling was done at highway construction sites in Las Vegas involving regrading, sampling in other areas[5,6] has shown emissions to be of the same magnitude as building construction emissions.

Table 2.1. EMISSION FACTORS FOR CLEARED AREAS

AQMA/Soil type	Emission factor, ton/acre/yr			
	Vegetation			
	None	Sparse	Moderate	Heavy
Las Vegas				
Rocky or demolition waste	0.78	0.64	0.51	0.18
Sandy	1.28	1.09	0.90	0.42
Fine	2.29	2.06	1.77	0.96
Clay loam	1.01	0.85	0.69	0.29
Reno				
Rocky or demolition waste	0.19	0.13	0.06	0.01
Sandy	0.30	0.23	0.16	0.03
Fine	0.55	0.44	0.34	0.09
Clay loam	0.24	0.18	0.11	0.02

If the basic emission factor presented in AP-42 (Supplement 5)[7] of 1.2 ton/acre/month and the suggested climatic adjustment factor were used for Reno, it would result in an emission factor about seven times as high as the one for Las Vegas. There is no basis for such disparity in the two emission rates. In fact, Las Vegas should have the higher emission rate if climatic conditions are to be the basis for regional variation. The value of 1.0 ton/acre/month is also recommended for use in Reno as the best available estimate.

During extended non-construction periods (greater than one month), emissions from exposed surfaces at the sites may be estimated with the emission factors for cleared areas described above.

SAND AND GRAVEL PITS

Sampling around aggregate handling and storage operations in two different geographic areas produced the following general emission factors:[4]

Inactive areas = 3.50 lb/acre/day
= 0.64 ton/acre/yr
Active areas = 10.40 lb/acre/day
= 1.90 ton/acre/yr

These values appear to be reasonable in comparison with emission factors for cleared areas for Reno, but low for Las Vegas. If a correction factor based on the ratio of climatic factors (C) or precipitation-evaporation (P-E) indexes squared for Las Vegas and the areas where the sampling was conducted (Kansas City and Cincinnati) is applied, the resulting values are ridiculously high. Therefore, it was assumed that the factors were correct for Reno, and the ratio of P-E indexes squared between Las Vegas and Reno was used to obtain an appropriate emission estimate for Las Vegas:

$$\text{Inactive areas} = (20/15)^2(0.64) = 1.14 \text{ ton/acre/yr}$$

$$\text{Active areas} = (20/15)^2(1.90) = 3.40 \text{ ton/acre/yr}$$

A discussion of the P-E index may be found in Chapter 4.

The above factors include emissions from such process areas as:

- storage piles
- loading and unloading
- haul roads and traffic areas
- excavation
- equipment parking

They do not account for emissions from crushing and sizing operations or batch plants commonly located at sand and gravel pits. These processes are included in point source emission inventories of the two study areas.

EQUIPMENT STORAGE AREAS

The emission factors for cleared areas should also be applicable for unpaved equipment storage areas unless there is frequent traffic on the storage lots. Storage areas generally do not have vegetation on them, so appropriate emission factors can be found in the first column of Table 2.1. For most storage lots, including those which have been graveled, the surface would be categorized as sandy.

PLAYGROUNDS AND ATHLETIC FIELDS

No published emission estimates for playgrounds were located. In order to provide some emission factor for this category, it was assumed that the emission rate was greater than for wind erosion alone but somewhat less than for construction activity on the same area. The emission rate would probably be much closer to that for wind erosion because playgrounds and athletic fields only have periodic daily and seasonal use. The emission factors for wind erosion and construction and the values proposed for playgrounds are summarized below:

Source category	Emission factor, ton/acre/yr	
	Las Vegas	Reno
Wind erosion (clay loam soil, flat, no vegetation)	1.01	0.24
Construction	12.00	12.00
Playgrounds, athletic fields	2.50	1.50

REINTRAINED DUST FROM PAVED STREETS

In some recent regional emission inventories,[8,9,10] PEDCo has used emission factors of 1.75 gm/VMT for clean paved streets and 77 gm/VMT for dirty paved streets for all days with no rain or snow cover. These values were based on very limited sampling done in the Seattle area[11] and were used by PEDCo with strong qualifications as to the accuracy of the resulting emission estimates.

Midwest Research Institute (MRI) is currently conducting a series of field tests specifically designed to develop emission factors for reintrained dust from paved streets. Their preliminary findings, not scheduled for finalization and publication until March 1976, indicate that streets in commercial and industrial districts with no street cleaning emit dust at a rate of 30 to 50 gm/VMT, with about 70 percent of the particulate matter less than 30 μ in diameter (the suspended particulate fraction measured by hi-volume sampler). Streets in residential areas and expressways, which have not yet been extensively sampled in this project, were estimated to have emission rates about half of that for the commercial/industrial streets.

The preliminary factor developed by MRI for dirty paved streets is based on much more sampling data than the previous factor and is therefore recommended for use even though it is still subject to modification prior to its official release. The emission factor is 28 gm/VMT (0.70 x 40 gm/VMT), to be applied on all days with no rain or snow cover. On the other hand, the basis for the 50 percent value is not clear and it intuitively seems quite high. Therefore, the value of 1.75 gm/VMT will still be used tentatively for emissions from clean paved streets until further clarification of the MRI value (14 gm/VMT) is obtained.

STREET SANDING FOR SNOW CONTROL

The sand or cinders distributed onto streets to improve vehicle traction during ice and snow storms remains on the road surfaces after the snow has melted. Vehicle movement grinds the material into smaller particles which can become airborne when the surface dries.

In previous fugitive dust inventories,[10] emissions from this source category have been estimated by: (1) determining the number of times per year that sand is dumped on the streets for snow control, (2) assuming that dust is emitted for an average of two days following each application, (3) determining the total daily VMT on the streets and highways where sand is applied, and (4) using the emission factor for dirty paved streets (77 gm/VMT or, in the present case, 28 gm/VMT).

Probably a more accurate procedure is to determine the number of tons of material dumped onto the streets and, based on characteristics of the sanding material and street configurations, then estimate the percentage of this material that eventually becomes airborne. Since the amount of sanding material (red cinders) applied in Reno during the winter of 1974-1975 is known, the latter procedure was used. It was estimated that 50 percent of the material became airborne, primarily because of the rapid decomposition characteristic of red cinder material. For clean quartz or granite sand, the percentage would be only about 10 percent.

There are no emissions from this source in the Las Vegas study area.

UNPAVED ROADS

Many different groups[3,5,11,12] have investigated emissions from unpaved roads. All the studies show emission rates usually in the range of one to 20 lb/VMT, and show that the rate is highly dependent on vehicle speed. After reviewing these studies, EPA selected the following emission factor for publication in AP-42:[7]

$$E = (0.6)(0.81)(s)(S/30)(1-365/W) \qquad \text{(eq.2)}$$

where E = emission factor, lb/VMT
0.6 = fraction of total particulate less than 30 μ diameter
s = percent silt of road surface material
S = average vehicle speed, mph
W = annual days with 0.01 in. or more rainfall or snow cover

This factor is proposed for use in the two Nevada study areas.

The percent silt on gravel road surfaces is about 12 percent based on data presented in the EPA publication, Development of Emission Factors for Fugitive Dust Sources.[3] For graded and drained road surfaces, no aggregate material is applied to the roadbed so it is composed of compacted native soil. The fine material originally on the surface is probably rapidly removed by turbulence from passing vehicles or by wind and water erosion forces. The remaining stable surface is composed of sand- and pebble-sized particles, with dust being generated primarily by the continuing mechanical breakdown of these particles as a result of traffic. It is assumed that the percent of silt-sized particles on a seasoned dirt road surface is approximately the same as that for gravel, or 12 percent.

Values for W were obtained from National Weather Service climatological summaries--33 for Las Vegas and 71 (including 13 days of snow cover) for Reno.

In the previous fugitive dust inventory work in Nevada,[5] an average speed of 30 mph was assumed. Better data may be available now from county highway department staff. If so, the estimated average speeds may be substituted into the equations below to obtain the emission factors:

$$E\ (\text{Las Vegas}) = 5.3(S/30)\,\text{lb/VMT}$$
$$E\ (\text{Reno}) = 4.7(S/30)\,\text{lb/VMT}$$

UNPAVED PARKING LOTS

If the average number of vehicles using a parking lot daily and the average distance of travel in the lot can be estimated, these data can be converted to VMT/yr and then multiplied by the emission factor for unpaved roads to determine unpaved parking lot emissions. With an average speed of 10 mph in the parking lots, the emission factors are:

$$E\ (\text{Las Vegas}) = 1.8\ \text{lb/VMT}$$
$$E\ (\text{Reno}) = 1.6\ \text{lb/VMT}$$

Usage of most lots for only five or six days per week should be considered in calculating annual VMT.

If only the area of the lot is known, it may be assumed that 20 cars park in an area of 10,000 sq ft. For most lots, the vehicles travel about 100 ft from the entrance and another 100 ft to the exit. The annual VMT based on these assumptions would be:

$$\text{Annual VMT} = (20 \text{ cars})(200 \text{ ft})(250 \text{ days})/5280 \text{ ft/mi}$$
$$= 190 \text{ VMT/yr per } 10{,}000 \text{ sq ft of lot}$$

$$E \text{ (Las Vegas)} = 0.17 \text{ ton/yr per } 10{,}000 \text{ sq ft}$$
$$E \text{ (Reno)} = 0.15 \text{ ton/yr per } 10{,}000 \text{ sq ft}$$

ROAD SHOULDERS

Fugitive dust from unpaved road shoulders may be emitted directly as a result of traffic driving on the shoulders or indirectly due to turbulence and eddies from fast-moving vehicles on the nearby paved surface. Direct emissions from traffic may be estimated by use of the unpaved road emission factor. An average vehicle speed of 10 mph on shoulders has been assumed, so the emissions per VMT are the same as for unpaved parking lots. Road shoulders receiving regular traffic were identified in the field survey, and the amount of traffic was estimated from the type and size of adjacent activity centers (e.g., schools, stores, service stations).

No estimates for tubulence-induced emissions on road shoulders were found. This is a difficult activity to characterize or inventory because of the many different shoulder materials and highway/shoulder configurations. To account for these emissions in locations where airborne dust from the shoulder area is visible, it is recommended that the emission factor for dirty paved streets be used. On shoulders where the emissions are not obvious, no procedure for quantifying the low-level emission rate has been determined.

RAILROAD RIGHT-OF-WAYS AND YARDS

Most of the emissions in train yards appear to be from wind erosion rather than from train movement. Also, these areas are generally treated with oil or chemicals to reduce dust and weed problems. Therefore, the emissions have been estimated with the cleared land emission factor and the following assumptions:

- no vegetation
- sandy soil
- half the area is stabilized, with an emission rate of 20 percent of the unstabilized area
- train traffic increases the wind erosion emissions by 20 percent (see Chapter 4)

$$\begin{aligned} E\ (\text{Las Vegas}) &= (1.28\ \text{ton/acre/yr})\left(\frac{1 + 0.2}{2}\right)(1.2) \\ &= 0.9\ \text{ton/acre/yr} \end{aligned}$$

$$\begin{aligned} E\ (\text{Reno}) &= (0.30\ \text{ton/acre/yr})(0.6)(1.2) \\ &= 0.2\ \text{ton/acre/yr} \end{aligned}$$

AGRICULTURE

The previous fugitive dust inventory of Reno[5] showed that hay was the only field crop grown in Washoe County, and that this crop produced negligible emissions. Agriculture is quite limited in the Las Vegas study area.

Total emissions from agriculture are calculated from the sum of tilling and wind erosion emissions. The factor for tilling from AP-42[7] is:

$$E = (0.8)(1.4)s/(P-E/50)^2 \qquad \text{(eq.3)}$$

where E = emission factor, lb/acre/run

0.8 = fraction of total particulate less than 30 μ diameter

s = percent silt in surface soil

P-E = precipitation-evaporation index (15 for Las Vegas, 20 for Reno)

An average of three tilling operations per year is assumed.

The modified wind erosion equation described at the beginning of this chapter is recommended for determining the wind erosion component of agricultural emissions. All variables in the equation except C are dependent on either the soil type or crop grown on each field, so a general emission factor for each study area cannot be calculated.

3. PARTICLE SIZE OF EMISSIONS

Only a few studies reporting particle size distributions of emissions from fugitive dust sources were found in the literature. The major study, Development of Emission Factors for Fugitive Dust Sources (MRI study),[3] contained extensive data on particle size distributions for three of the sources--unpaved roads, agriculture, and aggregate handling. Sampling data and an idealized size distribution function for emissions from a cleared area in the San Joaquin Valley were reported by Battelle Northwest Laboratory,[13] and a German publication presented extensive data on size range of emissions from aggregate handling (sand and gravel processing).[14]

The other source of information on particle size distributions was some previously unreported Andersen fractionation data obtained by PEDCo in its 1972 investigation of fugitive dust in four southwestern states. These data were obtained with 14 Andersen sampling heads (mounted on standard hi-volume samplers) located at seven different source exposures--three unpaved road sites, two construction sites, and two agricultural sites. One of the construction sites was in Las Vegas, and one of the unpaved road sites had a paved section for evaluation of control efficiency. The sampling period was ten weeks.

The combination of studies cited above provides at least one set of size distribution data for six of the 12 fugitive dust categories, including all the major ones. Emission factors for the remaining six categories were derived from available factors for other fugitive dust sources, so it seems appropriate that particle size distribution data for these other sources also be applied in estimating emissions by particle size range. The six categories with no size distribution data and the proposed substitute for each are:

Source category	Size distribution data
Equipment storage areas	Cleared areas
Playgrounds	Cleared areas
Railroad right-of-ways and yards	Cleared areas
Street sanding for snow control	Unpaved roads
Unpaved parking lots	Unpaved roads
Road shoulders	Unpaved roads

Different particle fractionation procedures were used in each of the four studies which contributed data:

Study	Particle fractionation procedure
MRI	Andersen impactor, hi-vol, and large particle sampler (profiler)
Battelle Northwest	Andersen impactor, sieving of dust on internal surfaces of collecting cowl
German	Gonell classifiers (measured by settling velocity)
PEDCo	Andersen impactors

The four stage, multiorifice Andersen impactor and a backup filter separate particulate matter into five aerodynamic size ranges: 7 μ and larger, 3.3 to 7 μ, 2.0 to 3.3 μ, 1.1 to 2.0 μ, and 0.01 to 1.1 μ. These are for densities of 1.0, so the actual size ranges are slightly smaller for fugitive dust, which has a density of about 2.[13] Like the standard hi-volume sampler, the Andersen impactor has an effective upper cutoff of about 30 μ particle diameter because of sampling intake configuration.[3] Therefore, the percentages obtained with the Andersen impactor alone (PEDCo data) tend to overestimate the actual percentage weights of small diameter particles and underestimate the percentage weights of large diameter particles. This bias has been accounted for in developing the final data on particle size distribution.

The size distribution data from the different studies are shown by source category in Figures 3.1 through 3.6. The graphs are plotted on log-probability scale, which produces a straight line for a log-normal distribution of particles by weight.

Data from the graphs are summarized into three size ranges in Table 3.1: less than 3 μ (respirable), 3 to 30 μ (suspended particulate measured with high efficiency by hi-volume sampler), and greater than 30 μ (particulate emission fraction subject to settling with increasing distance from its source). For construction emissions (Figure 3.1), only the Las Vegas sampling data were used to determine the relative percentages. For aggregate handling and agriculture (Figures 3.3 and 3.6), the different curves were combined to calculate average percentages. Only the MRI curves were used to estimate the particle size percentages for unpaved roads (Figure 3.4), since the PEDCo data appeared to exhibit the bias toward small particle sizes described above. For this same reason, the PEDCo data for paved roads (Figure 3.5) was corrected to show 20 percent by weight of the particles less than 1 μ, the average value for the other size distribution functions. This is equivalent to assuming that the Andersen impactors failed to collect about 12 percent of the total suspended particulate, all with diameters greater than 30 μ.

The values in Table 3.1 can be used to establish emission rates by particle size range. However, in most cases the emission factor has already been adjusted so that it

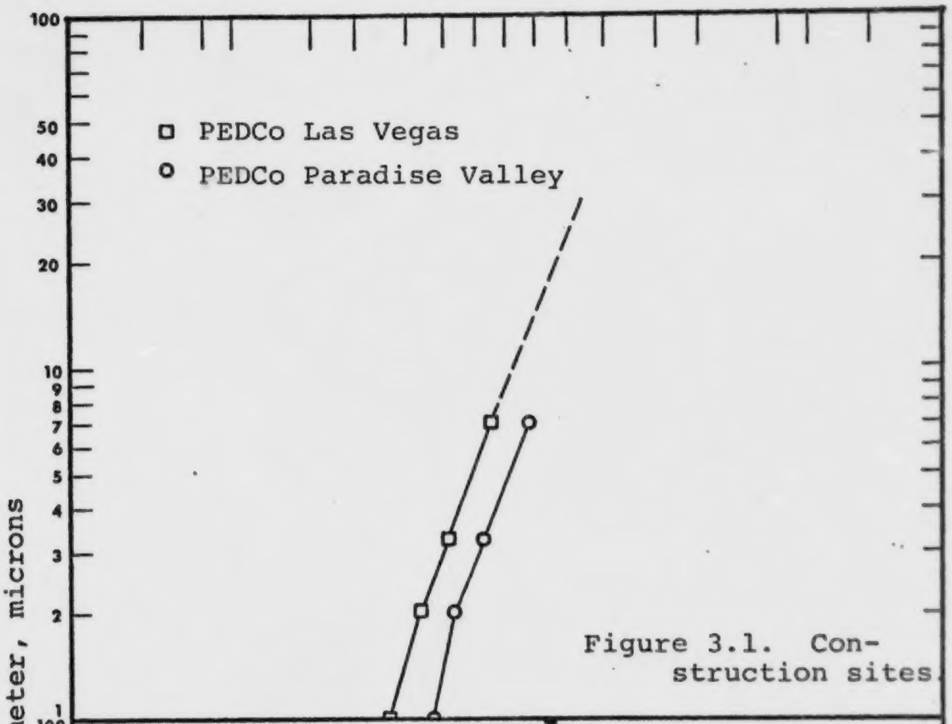

Figure 3.1. Construction sites.

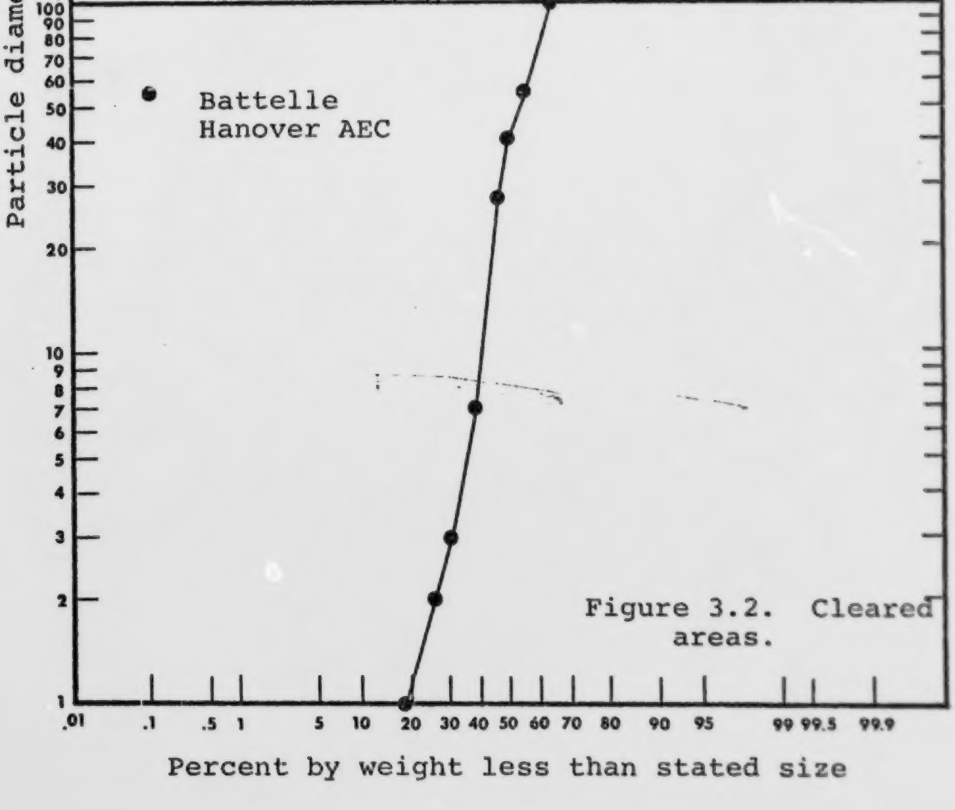

Figure 3.2. Cleared areas.

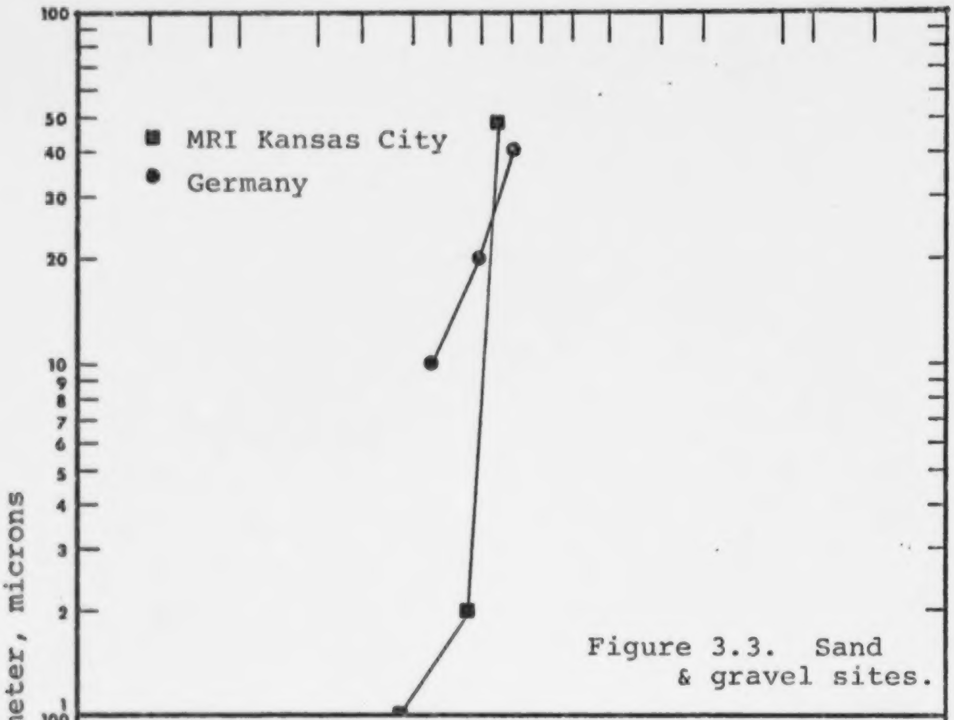

Figure 3.3. Sand & gravel sites.

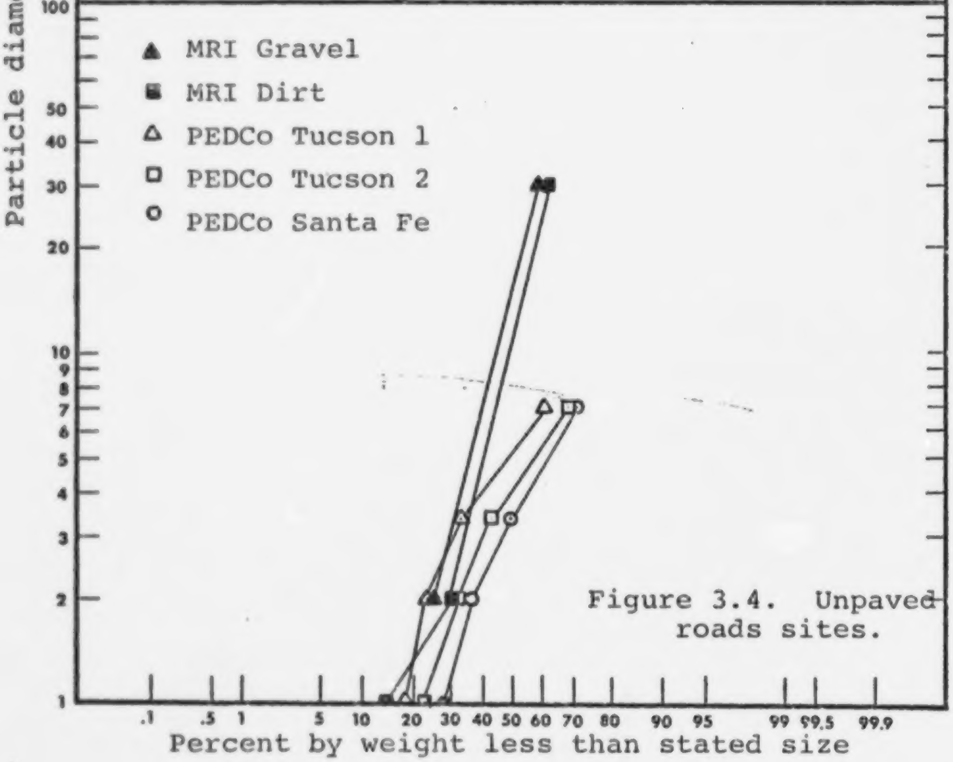

Figure 3.4. Unpaved roads sites.

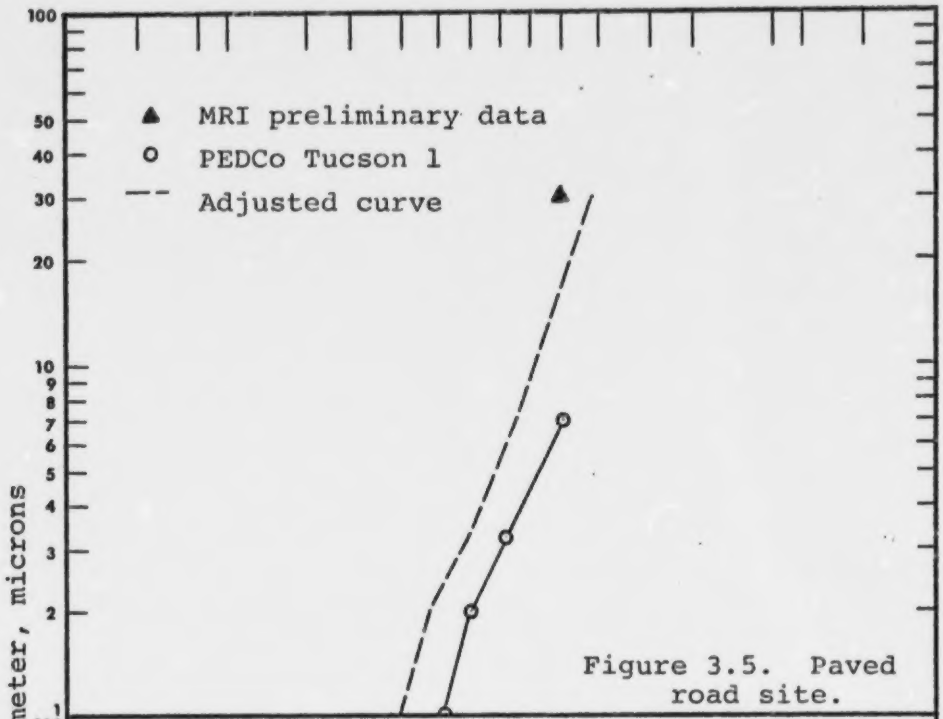

Figure 3.5. Paved road site.

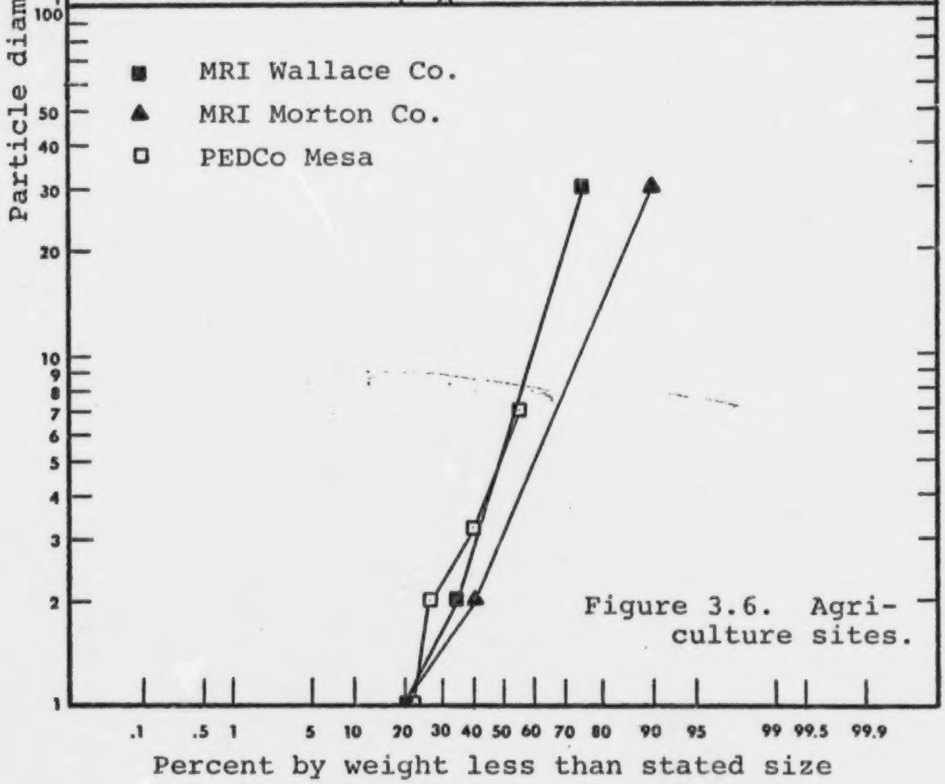

Figure 3.6. Agriculture sites.

Table 3.1. PARTICLE SIZE DISTRIBUTIONS FOR FUGITIVE DUST EMISSION SOURCES

Source category	Percent by weight of particulate emissions by size range		
	< 3 μ	3–30 μ	> 30 μ
Construction	32	40[b]	28[b]
Cleared areas	30	14	56
Sand and gravel pits	30	23	47
Unpaved roads	31	29	40
Paved roads	40[a]	37[b]	23[b]
Agriculture	40	41	19

[a] Andersen data adjusted with assumption that 12 percent of particulate, all > 30 μ, was not collected by sampler.

[b] Frequency distribution curve extrapolated linearly to 30 μ.

accounts only for the fraction less than 30 μ in diameter, so only the relative percentages for the two smaller size ranges should be used.

A review of these results indicates that the fugitive dust sources all have similar size distributions, especially considering the different studies and sampling methods involved. This finding supports a conclusion made in Chapter 4 of this report in evaluating the effect of soil type on emission rate: the same sizes of particles appear to contribute to atmospheric particulate concentrations regardless of the grain size distribution of the parent soil.

This conclusion implies that the particle size distributions shown in Table 3.1 are probably applicable for Las Vegas and Reno, even though the sampling was done elsewhere. However, data specific to the two study areas would certainly be desirable to improve the accuracy of the emission estimates and to provide a direct comparison with the ambient particle size distribution data now being generated with Andersen impactors in the two areas.

4. FACTORS AFFECTING EMISSION RATES

All parameters which might possibly affect fugitive dust emission rates were investigated and pertinent data on each were assembled. The primary purpose of this task was to identify data for the development of correction functions for fugitive dust emission factors which do not already have them and to check the applicability of existing correction functions.

Six different parameters were found to substantially influence fugitive dust emission rates--soil type, windspeed, surface moisture, precipitation, vegetative cover, and traffic activity on the surface. The information developed on each of these six parameters is discussed separately in this chapter. The fugitive dust source categories to which each of these parameters is applicable are summarized in matrix form in Table 4.1.

SOIL TYPE

Soil type was shown to be an important variable. It affects almost all fugitive dust sources, since it is usually the native soil from the surface of the source that becomes airborne as the suspended particulate emission.

Two different characteristics of soil are most important in determining emission rates: (1) soil structure, or its resistance to breakdown into its component particles; and (2) soil texture, or the size distribution of the individual component particles. Such factors as cloddiness (soil cohesion), surface crusting, bulk density, and mechanical stability give a soil its "structure." Soil texture provides an indication of the potential amount of suspended particulate

Table 4.1. FACTORS AFFECTING FUGITIVE DUST EMISSION RATES

	Parameter					
Source category	Soil type	Wind speed	Soil moist.	Ppt.	Veg. cover	Traffic
Cleared areas	✓,I	✓,C	✓,C	✓	✓,VMT	✓
Active construction	✓		✓	✓		✓
Sand and gravel pits			✓,P-E	✓		✓,A
Equipment storage areas	✓,I	✓,C	✓,C	✓	✓✓	✓
Playgrounds	✓✓	✓,C	✓,C	✓	✓✓	✓✓
Paved streets				✓,W		✓,VMT
Street sanding	✓[a]			✓		✓,VMT[b]
Unpaved roads	✓✓			✓,W		✓,VMT
Unpaved parking lots	✓✓			✓,W		✓,VMT
Road shoulders	✓✓		✓	✓,W		✓,VMT
Railroad yards	✓✓	✓,C	✓,C	✓	✓✓	✓✓
Agriculture	✓,I	✓,C	✓,C,P-E	✓	✓,VMT	✓,N

[a] type of sanding material

[b] for one of two alternate methods

LEGEND

✓ = parameter significantly influences emission rate.

✓✓ = an assumption in the emission factor derivation accounts for this parameter.

Letters following the checkmark denote specific variables in an equation for calculating the emissions or emission factor which account for the effect of the parameter.

A = active or inactive operations
C = climatic factor
I = soil erodibility x suspended fraction
N = number of tilling operations per yr
P-E = precipitation-evaporation index
VMT = vehicle miles traveled
W = days with rainfall or snow cover

that can result if wind erosion or repeated mechanical disturbance of the soil causes the disintegration of the soil's natural structure.

The particle size distribution, or texture, of a soil is an important factor in defining a soil's structure. For example, soils containing a high proportion of silt form the most stable clods and most compact crust.[4] Since the two soil characteristics which affect emission rate are somewhat dependent on one another, soil scientists have generally used soil texture as the single basis for comparing the erodibilities and potential dust emission rates of different soils.[2]

The standard measure of dust losses from soil surfaces is the erodibility index, I, in units of ton/acre/yr. This index estimates the relative erodibility of different soil surfaces, not the actual quantities erodible under field conditions. The erodibility indexes for different soil textures are shown in Table 4.2.

In previous fugitive dust emission factor development, either the erodibility index or the percent silt was used as the correction function to account for different soil types.[3,5,7] However, both of these parameters have shortcomings. The erodibility index estimates the relative soil loss for different soil types, but does not adequately account for the greatly varying percentages of that total soil loss which are in the suspended particulate size range and thus available to become airborne. Example percentages are shown in Table 4.2. Most of the eroded soil is suspended for a short distance and then resettles, or is pushed along the ground. The latter movement is called saltation and surface creep.

The use of silt content as the correction factor is an attempt to account for the amount of soil in the suspended particulate size range, but it does not consider the structural resistance of silty soils to breakdown into the individual particles.

Table 4.2. ERODIBILITY AND AVERAGE PERCENT SUSPENDED PARTICULATE-SIZED PARTICLES BY SOIL TYPE

Soil texture	Erodibility index, ton/acre/yr[a]	Aggregates < 0.05 mm, percent by weight[b]
Sand	220	0.9
Loamy sand	134	1.0
Sandy loam	86	2.1
Clay	86	0.8
Silty clay	86	0.8
Loam	56	6.6
Sandy clay loam	56	4.1[c]
Sandy clay	56	1.0[c]
Silt loam	47	4.1
Clay loam	47	2.5[c]
Silty clay loam	38	4.1
Silt	38	0.8[c]

[a] Source: D. G. Craig, J. W. Turelle. Guide for Wind Erosion Control on Cropland in the Great Plains States. U.S. Department of Agriculture, Soil Conservation Service. July 1964. Table 1.

[b] Source: W. S. Chepil. Soil Conditions that Influence Wind Erosion. U.S. Department of Agriculture, Agricultural Research Service and Kansas Agricultural Experiment Station, Washington, D.C. Technical Bulletin Number 1185. June 1958. Table 1.

[c] Estimated from most similar soil types.

Comparative particle size ranges for different soil types and soil movements are shown in Figure 4.1. The particle size limits shown in the figure are approximate--they depend on particle density, shape, and surface forces as well as size. Loam, the fourth soil texture used in the classification system, is a mixture of clay, silt, and sand.

It is recommended that the relative dusting potential of different soil types be estimated from the product of their erodibility index and average percent of suspended particulate-sized particles (less than 0.05 mm):

Soil texture	Correction weighting factor
Sand	1.98
Loamy sand	1.34
Sandy loam	1.81
Clay	0.69
Silty clay	0.69
Loam	3.70
Sandy clay loam	2.30
Sandy clay	0.56
Silt loam	1.93
Clay loam	0.94
Silty clay loam	1.56
Silt	0.30

The normal crusting characteristics of the soils are considered in their erodibility indexes. However, under certain conditions natural crusting can be enhanced by surface treatment with chemicals, compaction, or controlled watering. A soil surface that is well crusted loses dust at a rate about one-sixth that of the same soil in a non-crusted state.[4] If the surface is not completely crusted, or if the crust is weathered or damaged by traffic, the emission rate will be intermediate between an unprotected and a well-crusted surface.

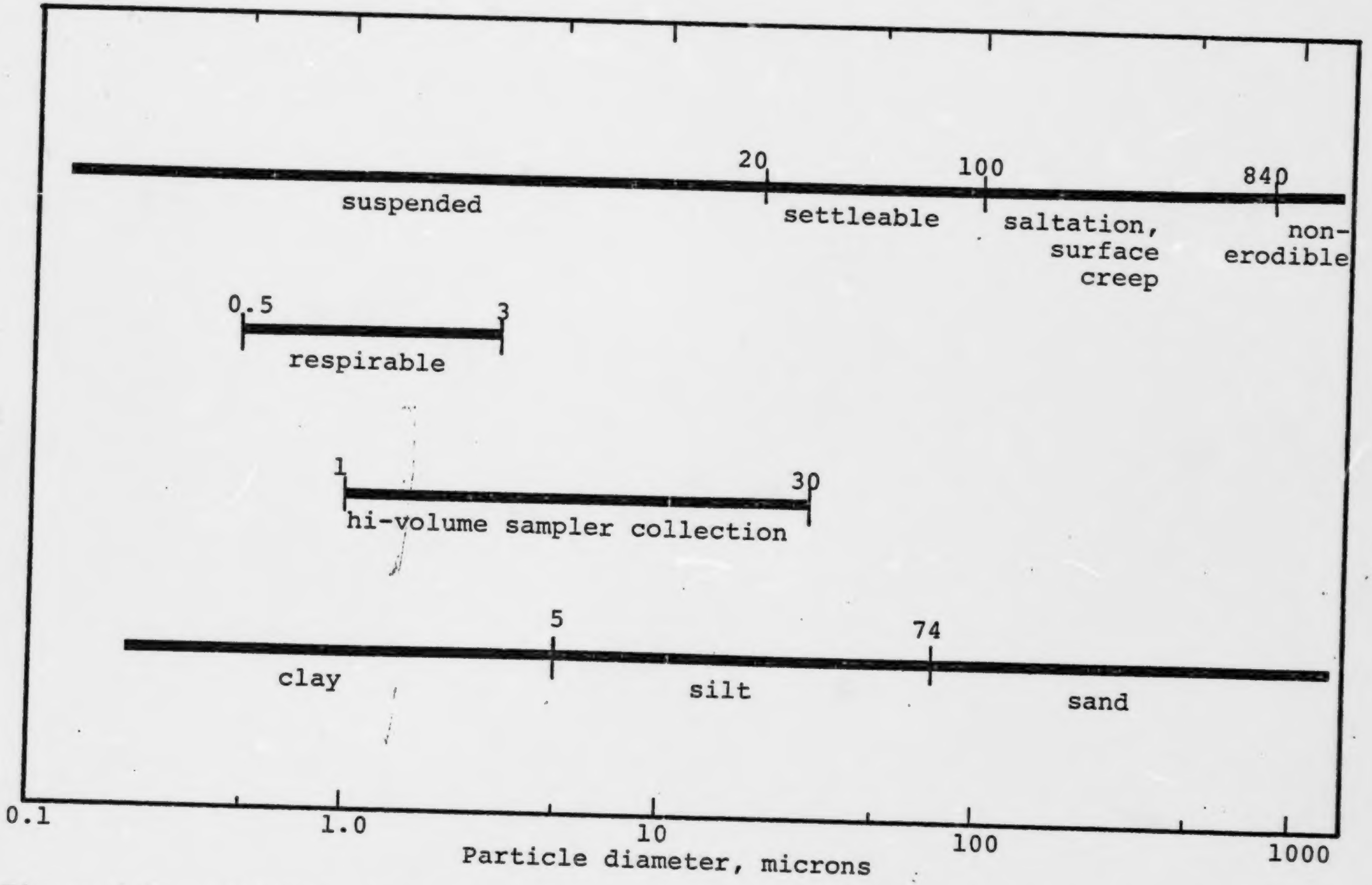

Figure 4.1. Particle size ranges for soil types and soil movements.

A study of particle size distributions in the atmosphere indicated that these distributions are quite similar in all regions and appear to be independent of the prevailing soil types in the region (except in the case of dust storms).[13] This conclusion is certainly not in conflict with the assumption made in the above discussion that emission rate from a soil surface is a function of the percent of soil particles in the suspended particulate size range. Essentially, the same sizes of particles appear to contribute to atmospheric particulate concentrations regardless of the size distribution in the parent soil.

Soils undergo seasonal changes in their erodibility as a result of biological activities and alternate wetting and drying and freezing and thawing. These actions decrease cloddiness and mechanical stability of the soils in winter in all areas where the soil is moistened at least occasionally and increase cloddiness and mechanical stability during the summer.[4] Because of the southern desert climate of Las Vegas, seasonal changes in soil structure in this study area are probably not significant. Available data on seasonal changes in erodibility are insufficient to accurately quantify this impact in Reno. The amount of seasonal change in erodibility is also a function of soil type.

WINDSPEED

Windspeed affects emission rates primarily for the wind erosion sources, e.g., cleared land and agriculture.

Several investigators have found that when windspeed is greater than that required to barely move the soil, the rate of soil movement is directly proportional to the friction velocity cubed.[15] The friction velocity at the surface is proportional to windspeed measured at a height above the ground, so the rate of soil movement is also proportional to the ambient windspeed cubed after it attains some minimum or threshold speed necessary to initiate movement.

One investigator reported threshold speeds to range from 13 to 30 miles per hour (mph) at 1-foot height, depending on the history of the field.[16] Other investigators have found threshold velocities as low as 9 and 11 mph at about the same height.[17,18]

The threshold velocity is influenced by the size of soil particles on the surface, and is lowest for aggregates of 0.10 to 0.15 mm in diameter. As shown in Figure 4.2, the threshold velocity increases with either an increase or decrease in the size of particles outside this range. The high resistance of fine dust particles to erosion by wind appears to be due partially to cohesion but mainly to the fact that the particles are too small to protrude above a laminar and viscous layer of air close to the surface of the ground. Fine dust is lifted from the ground mainly by impacts of larger grains, which are more erodible because they protrude farther into the fast moving, turbulent currents of higher air.

Turbulence is as important as average forward velocity in lifting and transporting the soil. Thus, maximum momentary wind velocity and gustiness also are factors in determining the impact of windspeed on fugitive dust emission rates. All surface wind velocities over about 2 mph create some turbulence.[19]

One research report[15] recommended that the rate of soil movement be estimated as being proportional to the windspeed cubed times its duration above the threshold speed. In practice, it is difficult to obtain measurements of the duration above a given windspeed, such as 13 mph, because climatological summaries only record one- or three-hour averages. These averages are normally less than 13 mph, but may contain significant periods of time when the windspeed is greater than 13 mph. To avoid this problem, U.S. Department

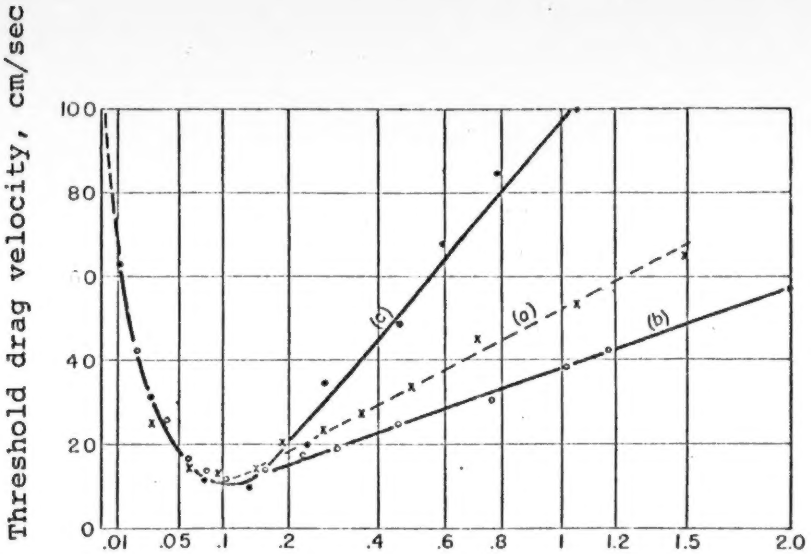

Figure 4.2. Relation between particle size and threshold drag velocity.

(a) Sieved fractions with ratios of maximum to minimum diameters of 1.7.

(b) Sieved fractions ranging in particle size from fine dust to diameter indicated by data point.

(c) Soil containing 15 percent non-erodible clods.

Source: W. S. Chepil. Soil Conditions that Influence Wind Erosion. U.S. Department of Agriculture, Agricultural Research Service and Kansas Agricultural Experiment Station, Washington, D.C. Technical Bulletin Number 1185. June 1958.

of Agriculture researchers have assumed that all locations have a similar windspeed frequency distribution and, therefore, that wind erosion potential in an area is proportional to the cube of the average windspeed for any specified period.

This assumption in turn creates a problem with lack of standardization in height and exposure of recording anemometers; i.e., an anemometer at 30 ft may record an average windspeed one to two mph higher than the same instrument at 20 ft height. Since the erosion rate is related to the cube of windspeed, this small difference causes a change of 30 to 100 percent in the resulting correction function.

The climatic factor, C, in the wind erosion equation is an available correction function that includes the average windspeed cubed term and also a term (Thornthwaite's precipitation-evaporation index) to account for surface moisture. Values for C have been compiled[3] for the entire country with the exception of the four southwestern states of California, Nevada, Arizona, and New Mexico--possibly because of the large potential errors when the P-E index term in the denominator approaches zero.

Recognizing the limitations to accuracy of any correction function that utilizes average windspeed data and the particular problem of determining appropriate values of C in Nevada, the climatic factor is still recommended as the correction function to reflect emission differences due to windspeed, because many available emission factors employ this term. Average annual windspeeds of 9.4 mph for Las Vegas and 6.6 mph for Reno were used to calculate annual C factors of 1.27 and 0.30, respectively ($C = 0.345\ v^3/[P-E]^2$). While the theoretical basis for use of the C factors may be weak, the values for the two areas appear reasonable in comparison with each other and with climatic factors published for other areas of the country.

Windspeed data for other locations in the study areas were not considered to be standardized enough to permit estimation of variations in wind erosion potential within the study areas.

Monthly variations in wind erosion forces have been estimated for 212 locations in the U.S. by the U.S. Department of Agriculture.[15] USDA's method of analysis is to sum the product of mean windspeed cubed and a duration factor for all speeds greater than 12 mph. The relative magnitudes of the wind erosion forces by month for Las Vegas and Reno are shown in Table 4.3. The same analysis indicates the prevailing wind erosion direction is from the south during the winter in both study areas, from the southwest for the remainder of the year in Las Vegas, and generally from the southeast for the remainder of the year in Reno. These findings are in close agreement with the pollution rose analyses done in the first task report for the present project.

SURFACE MOISTURE

The soil moisture content of a fugitive dust source directly affects the emission rate from the source. For any surface moisture content above air-dried, a distinct decrease in erodibility is observed.[20] Soil movement is reduced only slightly by the first moisture, but decreases more rapidly with additional moisture. At a moisture content approximately corresponding to the permanent wilting point for vegetation, soil loss is completely arrested. For different soil types, the percent water required to eliminate soil loss is:[20]

Soil type	Moisture content, %
Dune sand	1.28
Sandy loam	3.89
Silt loam	11.21
Silty clay	20.71

Table 4.3. MONTHLY VARIATIONS IN WIND EROSION FORCES

Month	Relative magnitude of wind erosion forces[a]		Seasonal adjustment for windspeed	
	Las Vegas	Reno	Las Vegas	Reno
January	124	151	0.53	1.20
February	242	165	1.04	1.31
March	330	188	1.42	1.49
April	350	191	1.50	1.51
May	395	157	1.70	1.24
June	327	130	1.40	1.03
July	244	96	1.05	0.76
August	208	94	0.89	0.74
September	179	68	0.77	0.54
October	171	84	0.73	0.67
November	108	81	0.46	0.64
December	120	110	0.52	0.87
Average	233	126		

[a] Source: Wind Erosion Forces in the United States and their Use in Predicting Soil Loss. U.S. Department of Agriculture, Washington, D.C. Agriculture Handbook Number 346. April 1968. Table 1, p 31.

Average surface moisture contents of soils are not routinely measured. Instead, Thornthwaite's precipitation-evaporation (P-E) index, calculated from the sum of 12 monthly ratios of measured precipitation to measured evapotranspiration, is used as an indicator.

Empirical data show that soil loss varies inversely as the square of the P-E index. The P-E values for Las Vegas and Reno are 15 (average of values for three regions in or near study area) and 20, respectively.

The P-E index value squared is included in the C factor previously described in the WINDSPEED section. Again, the C factor is recommended for use because of its acceptance as a broadly applicable correction factor.

Because of large variations in monthly rainfall, the monthly P-E values do not give meaningful monthly climatic factors.[21] Also, the P-E index is not precise enough to evaluate soil moisture conditions for periods as short as one month. The U.S. Department of Agriculture has not developed any seasonal variation function for surface moisture. In Las Vegas, the surface is probably dry enough to erode throughout the entire year, except on days with rain.

The correction factor for moisture content overlaps somewhat with that for precipitation. The distinctions made between the two are:

- Only average soil moisture for the entire year is considered, and this value is used to adjust the locally applicable emission factor to reflect emission rates with normal retained moisture.

- The correction factor for precipitation only applies to days with rainfall or snow cover and accounts for the total absence of dust emissions from very wet soil surfaces.

While different soil types stop dusting with greatly varying amounts of surface moisture (see data above), there is no information to indicate that surface moisture affects the particle size distribution of fugitive dust emitted from a particular source. In other words, surface moisture does not sort an erodible soil by differentially retaining certain fractions.

PRECIPITATION

As long as a soil surface is noticeably moist, it will not dust, even with traffic or surface activity.[4,20]

EPA's recommended emission factors for emissions from unpaved roads[7] assume that no emissions occur on days when there is measurable precipitation or snow cover. Analyses performed by PEDCo[3,5,22] and others[6] on particulate concentrations near fugitive dust sources on days with rain and no rain showed that hi-vol readings on rainy days are generally about half of those on non-rain days. Since these hi-vol measurements include some contribution from point sources, conventional area sources, and influx background in addition to fugitive dust, it appears that the combination of large reductions in fugitive dust emissions and rainout (during actual periods of rain) account for this 50 percent reduction in ambient concentrations. It can be shown that in some cases fugitive dust still occurs on days with rain, and may be even higher than normal due to strong winds that sometime precede thunderstorms. However, on an annual or seasonal basis, the current assumption embodied in EPA emission factors of no emissions on days with rain seems reasonable.

In most soils, crust formation due to rainfall has no permanent effect in reducing fugitive dust emission rates.[4] In fact, small showers tend to smooth the soil surface, loosen some surface particles, and accelerate rather than alleviate soil movement by wind. The Soil Conservation

Service in Las Vegas reported that rains in that area usually renew surface crusts in undisturbed soils by forming cements with water-soluble minerals.[23] However, rains may also bring additional fines to the surface in areas that have been cleared or disturbed and cause a temporary increase in dusting after the surface dries. A related natural phenomenon, the seasonal deposition onto a lake bottom of fine particles from water erosion and subsequent wind erosion of the dried lake bed, provides another example of the secondary effects of rainfall on fugitive dust emission rates.

Several attempts have been made to demonstrate that the dust emission rate in an area increases with the number of days since the last rain,[3,22] as the surface becomes progressively drier (see SURFACE MOISTURE). This relationship has never been shown to exist, possibly due to actions such as those described above. For this project, the assumption is made that emission rate does not increase with time since rain.

The proposed method for incorporating the correction for precipitation is to count the number of days during the period of interest with rain and snow cover (using a National Weather Service climatological summary for a local station), convert this count to a percentage of the total days, and reduce the emission factor by this percentage. This method is directly adaptable to estimating seasonal variations.

VEGETATIVE COVER

Ground cover primarily affects fugitive dust generated by wind erosion. Vegetation reduces wind erosion losses in two different ways. First, it absorbs some of the drag at the surface and decreases the wind velocity locally. Secondly, the roots of the plants act as a soil binder. The retained moisture necessary to support shallow-rooted vegetation also reduces the rate of soil loss.

The initial ground cover on a field usually provides more protection than additional increments of vegetation.[4] The relationship between the amount of vegetation and wind erosion rate is best quantified in U.S. Department of Agriculture's wind erosion equation,[1,2] which has been developed with over 30 years of experimental data.

The amount of vegetation is measured in lb/acre of air-dried residue. For ground cover more than about 250 lb/acre, additional vegetation reduces soil loss approximately linearly. In the Reno area, any ground cover greater than about 1000 lb/acre essentially eliminates soil loss. About 2000 lb/acre is needed in Las Vegas to stop all soil loss because of the different climate and soil conditions. Reference 2 provides a good description of methods for estimating the amount of vegetative cover on a field.

In the field surveys for the microinventories in the present project, the encroachment of vegetation onto cleared areas (as distinguished from natural vegetation in open terrain) was characterized into one of four groups--none, sparse, moderate, or heavy--corresponding to 0, 250, 500, and 1000 lb/acre. Specific emission factors were calculated for different C and I values using the wind erosion equation; however, the emission reductions associated with these four amounts of ground cover were approximately 0, 20, 40, and 80 percent, respectively.

The amount of vegetation obviously changes seasonally. Due to the wide range in seasonal changes for different plants, it is difficult to quantify this factor for use as a seasonal correction function. Deciduous trees and bushes are reported[2] to lose 20 to 40 percent of their effectiveness when they are defoliated in the winter. For Reno, this range may provide a usable estimate of average seasonal variations due to vegetation--a 20 percent increase from annual emission rates during winter and a 20 percent reduction during summer for sources with ground cover (the survey period was in autumn). Seasonal variations in the southern desert vegetation of Las Vegas are probably not significant.

TRAFFIC ACTIVITY

Traffic movement over unpaved surfaces causes dust to be thrown into the air at contact points between the vehicle and the surface or pulled into the air by the vehicles' wakes. Also, traffic may break protective surface crusts and leave the soil more susceptible to subsequent wind erosion. Thus, surface activity has a direct, immediate effect on emission rates and an indirect, longer term impact.

The fugitive dust emitted by traffic movement is related to the amount of traffic or activity and its average speed. For many source categories, such as road shoulders and construction, it is difficult to find an activity parameter for which data are generally available. For sources with automotive traffic (unpaved roads, unpaved parking lots, paved streets, and street sanding for snow control), the emissions are assumed to be directly proportional to vehicle miles of travel (VMT) even though there would be a small amount of emissions from these sources with no traffic. For agricultural tilling, the number of tilling operations per year on the fields is used as the measure of activity. For aggregate storage operations, traffic levels in the storage area are simply classified as active or inactive.

Several studies[3,5,11,12] have examined the effect of average vehicle speed on emission rates from unpaved roads and have variously proposed that the emission rate is linearly dependent on,[3] a function of the square of,[11] or exponentially related to[5] vehicle speed. Since these analyses were each based on data for only three or four different speeds, it could be anticipated that many different curves would approximately fit the experimental data points. The important conclusion is that all these studies show emission rates increase with higher vehicle speeds throughout the normal operating range of the vehicles. Within the range of accuracy of the basic emission factor and the experiment designs it may be assumed that the actual relationship and the resulting correction function should be linear. The current EPA-recommended emission factor for unpaved roads incorporates a linear correction for average speed.

The only study[24] identified which investigated the effect of speed on emissions from paved streets concluded that the relationship is also linear. However, the availability of material on the road surface for resuspension may be a limiting factor on the emission rate from this source. More data are needed to establish this correction factor.

A speed correction function for agricultural tilling has also been reported.[3,25] However, most farm implements are designed to operate over a narrow speed range and, as a practical consideration, there are usually no means of obtaining data on actual operating speeds when performing an emission inventory. Similar situations exist for vehicular traffic at construction sites and aggregate storage areas. Therefore, it is recommended that speed correction functions not be developed for any source categories other than paved and unpaved roads.

For sources such as roads and construction sites that have continual traffic, it has been determined that most of the fugitive dust results directly from traffic movement. For plowed fields and cleared areas, the total emissions are due to a combination of surface traffic and wind erosion. Total agricultural emissions may be estimated by calculating the tilling and wind erosion components separately. The recommended emission estimation procedure for cleared areas utilizes the wind erosion equation, but it may be appropriate to add a specified percentage to the estimated emissions if it is determined that there is surface traffic over the cleared area. Correction values of five percent for occasional traffic (1 veh/day) and 20 percent for regular traffic (5 veh/day) were calculated from the previous estimates of the relative impacts of traffic and wind erosion on unpaved roads.

Traffic activity over native surfaces tends to destroy the surface crust or layer of pebble-sized particles ("desert pavement") that normally shield the surface from further wind erosion. The increase in emissions due to this traffic is a function of the surface area with tire tracks and the extent of damage to the natural protection. As mentioned previously in the SOIL TYPE section, an uncrusted surface loses soil at a rate about six times as great as a completely crusted surface. Therefore, a correction function for background in areas with off-road traffic could be calculated as follows:

$$\text{correction function} = 1 + 5\left(\frac{\text{area with damaged surface}}{\text{total area}}\right)\left(\begin{array}{c}\text{fraction of crusting lost}\\ \text{in disturbed areas}\end{array}\right)$$

Seasonal variations in a traffic correction function are dependent primarily on seasonal variations in activity (VMT, plowing operations, etc). The decision of whether to apply seasonal corrections should be based on the availability and quality of such data.

5. CORRECTION FUNCTIONS FOR EMISSION FACTORS

Examination of Table 4.1, Factors Affecting Emission Rates, reveals that, with a few exceptions, appropriate correction functions are already included in the emission factors described in Chapter 2. Four exceptions are:

- Precipitation is not considered as a correction function for eight source categories, although emissions from these sources are greatly reduced on days with precipitation.
- Emissions from road shoulders vary with surface moisture content, which is not included as a correction function for the source.
- Four of the six parameters investigated affect emission rates from construction, but the proposed emission factor has no correction function.
- Traffic on cleared areas and equipment storage areas increase emission rates, but this is not considered in their proposed emission factors.

Precipitation is not included as a correction function for many of the source categories because their emission rates already consider annual climatic conditions (e.g., precipitation-evaporation index), which in turn are related to the amount and number of days with rainfall. Similarly, the moisture content of unpaved shoulders is reflected in the correction for days with rainfall.

Emissions from construction are influenced by many variables for which little or no field testing data are available (e.g., type of equipment in use, depth of excavation or regrading, effectiveness of watering). Application of correction functions to account for factors such as traffic and surface moisture would necessarily have to include a study of many of these significant variables. Without extensive new sampling data, suitable correction functions cannot be developed.

An approach for considering the effect of traffic on cleared areas is discussed in Chapter 4. These corrections, five percent for occasional traffic and 20 percent for regular traffic, are proposed for use with the base emission factors for cleared areas and equipment storage areas.

The percentages of emissions by particle size range were derived in Chapter 3. The final emission factors presented here contain only two size ranges--less than 3 μ (respirable) and 3 to 30 μ--because all the emission factors were developed for particulates less than 30 μ.

The fugitive dust emission factors by particle size range with correction functions are summarized in Table 5.1.

The data presented in Chapter 4 indicated that four of the six factors affecting emission rates were subject to significant seasonal variations in their influence: windspeed, precipitation, vegetative cover, and traffic activity. Therefore, the resulting emissions from the affected source categories should display seasonal variations. The magnitude of these variations is shown in Table 5.2, and combined seasonal adjustment factors by source category are summarized in Table 5.3.

Locational variations in emission rates from fugitive dust sources within each study area were shown to be primarily linked to soil type. Detailed soil maps of the two areas have recently been obtained from the Soil Conservation Service, and these locational variations will be described fully as part of the regional emission inventories in the Task C report.

Table 5.1. EMISSION FACTORS FOR NEVADA PARTICULATE STUDY

Source category	Emission factors,		Units	Particle size, %		Correction functions incorporated	Other corrections
	Las Vegas	Reno		<3μ	3-30μ		
Cleared areas	See Table 2.1		ton/acre/yr	68	32	Soil type, climate vegetation cover	Traffic-1.05 for occasional (1 veh/day), 1.20 for regular (5 veh/day) Stabilization-0.2 for complete crusting
Active construction	1.0	1.0	ton/acre/mo	44	56	Only during periods of active construction	
Sand & gravel pits							
Active areas	3.4	1.9	ton/acre/yr	57	43	Active/inactive, surface moisture	
Inactive areas	1.14	0.64					
Equipment storage areas	1.28	0.30	ton/acre/yr	68	32	Soil type (sandy assumed), climate, vegetation cover (none assumed)	Traffic-same as for cleared areas Stabilization-same as for cleared areas
Playgrounds & athletic fields	2.5	1.5	ton/acre/yr	68	32	Soil type (clay loam assumed), climatic, vegetative cover (none assumed)	
Paved streets							
Normal	1.75	1.75	gm/VMT	52	48	Traffic volume	Ppt.-no emissions on days with rain or snow cover Speed-need a speed correction function
Dirty	28.0	28.0					
Street sanding	none	28.0 50.0	gm/VMT % of sand distributed	52	48	Traffic volume, type of sanding material	
Unpaved roads	5.3	4.7	lb/VMT	52	48	Soil type (gravel assumed), ppt., traffic volume	Speed-correction function of S/30
Unpaved parking lots	1.8	1.6	lb/VMT	52	48	Soil type (gravel assumed), ppt., speed (10 mph assumed), number of cars parked	
Road shoulders							
Traffic	1.8	1.6	lb/VMT	52	48	Soil type (gravel assumed), ppt., speed (10 mph assumed), traffic volume	
Turbulence-induced	28.0	28.0	gm/VMT				
Railroad yards and right-of-ways	0.9	0.2	ton/acre/yr	68	32	Soil type (sandy assumed), climate, veg. cover (none assumed), traffic, stabilization (50% assumed)	
Agriculture							
Tilling	12.4s	7.0s	lb/acre/run	49	51	Soil type, climate, vegetative cover, crop type	Traffic-number of tilling operations
Wind erosion	Mod. wind erosion equation		ton/acre/yr				

Table 5.2. SEASONAL VARIATIONS IN FUGITIVE DUST EMISSIONS

AQMA	Parameter	Seasonal variation, ratio to annual average emission rate: Winter	Spring	Summer	Autumn
Las Vegas					
	Windspeed	1.0	1.5	0.9	0.6
	Precipitation	1.0	1.0	1.0	1.0
	Vegetative cover	1.0	1.0	1.0	1.0
	Activity	varies by source category			
Reno					
	Windspeed	1.3	1.3	0.7	0.7
	Precipitation	0.8	1.0	1.2	1.0
	Vegetative cover	1.2	1.0	0.8	1.0
	Activity	varies by source category			

Table 5.3. SEASONAL ADJUSTMENT FACTORS BY SOURCE CATEGORY

Source category	Parameters affecting emission rate				Seasonal adjustment factor, ratio to annual average emission rate							
					Las Vegas				Reno			
	Wind speed	Ppt.	Veg. cover	Activity	Wnt	Spr	Sum	Fal	Wnt	Spr	Sum	Fal
Cleared area	x		x		1.0	1.5	0.9	0.6	1.6	1.3	0.6	0.7
Active construction												
Sand & gravel pits												
Equipment storage	x				1.0	1.5	0.9	0.6	1.3	1.3	0.7	0.7
Playgrounds	x				1.0	1.5	0.9	0.6	1.3	1.3	0.7	0.7
Paved streets		x		x[a]	1.0	1.0	1.0	1.0	0.8	1.0	1.2	1.0
Street sanding				x[b]		0	0	0		0	0	0
Unpaved roads		x			1.0	1.0	1.0	1.0	0.8	1.0	1.2	1.0
Unpaved parking lots		x			1.0	1.0	1.0	1.0	0.8	1.0	1.2	1.0
Road shoulders		x			1.0	1.0	1.0	1.0	0.8	1.0	1.2	1.0
Railroad yards	x				1.0	1.5	0.9	0.6	1.3	1.3	0.7	0.7
Agriculture	x		x	x[c]	1.0	1.5	0.9	0.6	1.6	1.3	0.6	0.7

[a] Seasonal traffic data by area available from Nevada Department of Highways; not included in seasonal adjustment factors.

[b] All emissions occur during winter quarter.

[c] Standard tilling procedures will be determined for major farming operations; not included in seasonal adjustment factors.

Emissions from naturally occurring dust sources have not been quantified in this report, but they were reported to be strongly influenced by any traffic activity which damages the natural surface crust. A procedure for estimating the increase in emissions (and background concentrations) due to this traffic was presented in the TRAFFIC ACTIVITY section of Chapter 4. Other parameters which would affect naturally occurring dust emission rates are soil type and vegetative cover.

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TASK C REPORT - EMISSION INVENTORY AND EMISSION PROJECTIONS

PART 1. PARTICULATE EMISSIONS INVENTORY FOR LAS VEGAS, NEVADA

1. SUMMARY

The purpose of this project was to prepare an inventory of all point and area sources of particulate emissions in a study area centered around Las Vegas, Nevada for the period 1975 to 1985.

The area source categories included in this inventory are shown in Table 1.1. The list of categories is conventional except for several fugitive dust categories which have been included. The category of "Industrial Processes" has also been included to account for point sources. Individual point source listings are presented in Appendix A.

Particulate emissions are summarized by category for the base year (1975), and two projection years (1980 and 1985) in Table 1.1. Survey data, emission estimating procedures, and projection techniques that were used to obtain these values are documented in detail in Section 2 of this report for each source category.

In order to input area source emissions into an atmospheric dispersion model, the distribution of these emissions within the study area must be determined. This was accomplished by allocating the total emissions for each category into grid squares covering the entire study area, as shown in Figure 1.1. The grid system has a total of 148 grids made up of squares which are 2 km on a side within the urban region, and 5 km on a side in the more rural regions of the study area. The grid network is aligned to the UTM coordinate system, consistent with previous grid systems used in the Las Vegas Valley.

Table 1.1 LAS VEGAS PARTICULATE EMISSION
INVENTORY SUMMARY, TONS/YEAR

Source category	1975	1980	1985
Fuel Combustion:			
Residential	37.2	40.4	45.6
Commercial/Institutional	134.4	153.6	177.3
Industrial	55.8	61.6	68.0
Industrial processes	2986.0	3297.0	3640.0
Burning	51.9	55.2	59.2
Mobile Sources:			
Aircraft	71.8	78.0	87.1
Railroad	13.5	16.4	19.4
Auto exhaust	795.7	945.7	1064.1
Off-highway	206.8	236.3	272.8
Fugitive Dust Sources:			
Construction	620.0	706.0	796.0
Normal paved streets	2122.7	3477.6	4929.2
Dirty paved streets	43.9	-	-
Unpaved roads	5818.0	5818.0	5818.0
Sand and gravel pits	711.0	711.0	711.0
Agriculture	180.0	180.0	180.0
Various Fugitive Sources:			
Cleared areas	2309.9	2108.2	1906.5
Heavy equipment storage	27.6	27.6	27.6
Playgrounds	5.0	5.0	5.0
Unpaved parking lots	38.5	38.5	38.5
Road shoulders*			
Railroad right-of-ways	202.9	202.9	202.9
Horse corrals	51.0	51.0	51.0
Total	16483.6	18210.0	20099.2

* Road shoulder emissions included with unpaved parking lot emissions.

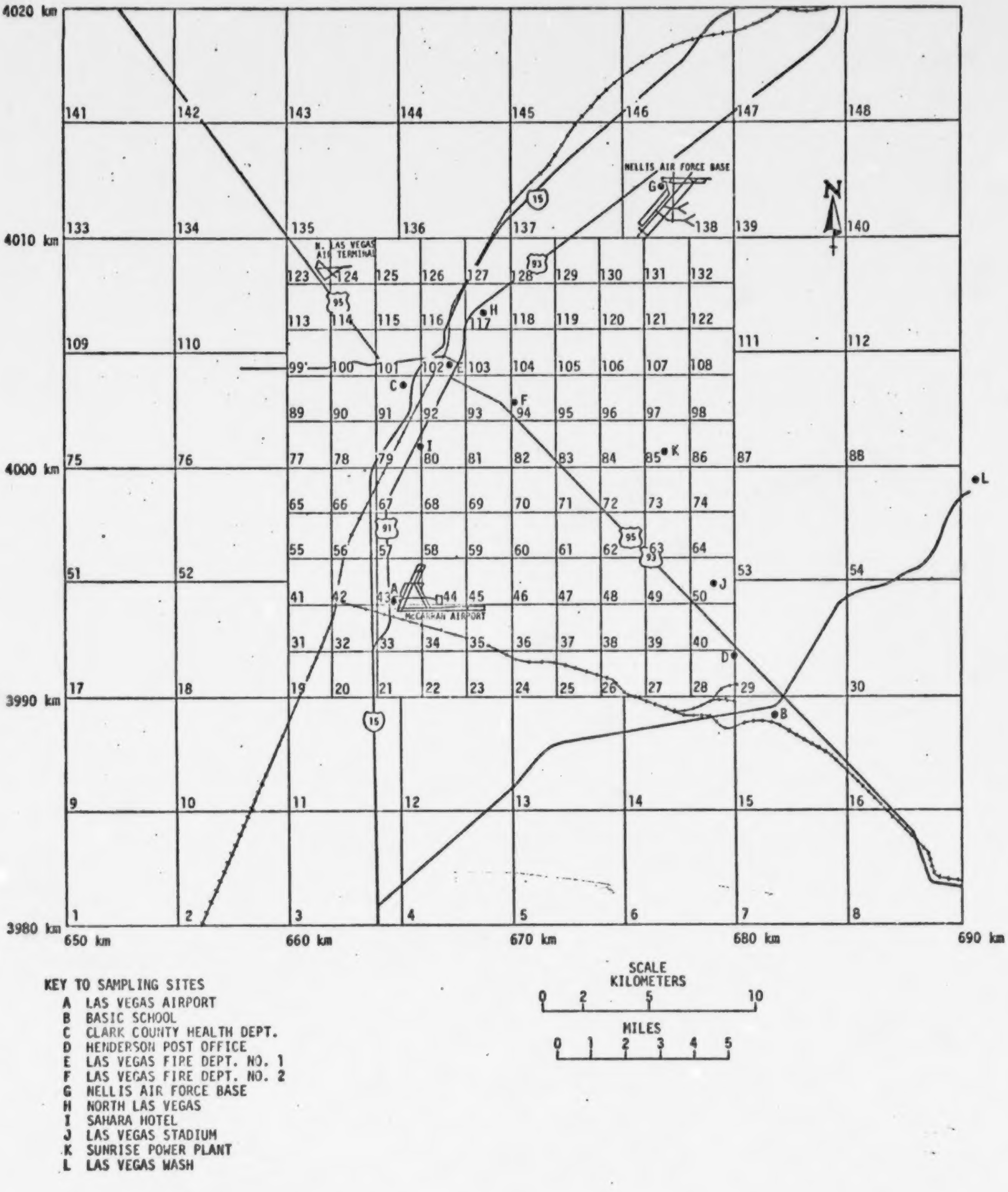

4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
N
NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
McCARRAN AIRPORT
15
93
95
91
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
KEY TO SAMPLING SITES
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH

Figure 1.1 Las Vegas study area with grid overlay.

The procedures used to allocate emissions to the grids for each source category are also explained in Section 2. The resulting emissions by grid and by source category are presented in Tables 1.2, 1.3, and 1.4 for the years 1975, 1980, and 1985, respectively. Emissions by grid from each of the various fugitive dust source categories are presented in Appendix B.

In general, emissions are observed to increase over time. However, care should be taken when drawing conclusions from the totals appearing in the summary tables. The emissions from a few sources, such as those from unpaved roads, which represent a large percentage of the total area-wide emissions, may in fact, have very little impact on the air quality due to the even distribution of these sources throughout the area. Sources which represent a smaller percentage of the total emissions could have a larger impact on air quality, if they are concentrated in a smaller area.

The source strength, or emission density of each grid is determined by dividing the total emissions from all sources in that grid by the area of the grid. Emission densities for all grids in each study year are shown in Tables 1.2, 1.3, and 1.4. Ranges of these emission densities are graphically displayed in Figures 1.2, 1.3, and 1.4 for the years 1975, 1980, and 1985, respectively. Note that the grids having higher emission densities occur in and near the urbanized areas. Grids in the more rural areas which have high emission densities are occupied by large point sources.

Hi-vol particulate samplers are located in many of the grids which have high emission densities. This shows that these samplers have been placed in areas where the highest particulate levels in the study area could be expected to be recorded.

Table 1.2. EMISSION SUMMARY BY GRID, LAS VEGAS 1975

(ton/yr)

	Stationary				Mobile			Fugitive dust								
Grid	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.	Total ton/yr	Emiss. dens, ton/ mi^2/yr
1											121				121.0	12.5
2					0.9						121			3.0	124.9	12.9
3					0.8	1.9			5.0		48			2.5	58.2	6.0
4						0.8			2.2		97				100.0	10.4
5																
6																
7									0.1		97				97.1	10.1
8						4.9			13.0					4.1	22.0	2.3
9											218			3.8	221.8	23.0
10					1.1	0.8		4.7	2.2		121			16.3	146.1	15.1
11	0.1				0.4	12.6	0.1		33.8					1.2	48.2	5.0
12	0.5			0.1		1.4	0.6	4.6	3.8		218				229.0	23.7
13						2.0		4.8	5.3						12.1	1.3
14					0.1	1.9		5.0	4.9					26.4	38.3	4.0
15	5.0			0.7	0.1	5.6	6.0	12.4	14.9		82			66.9	193.6	20.1
16											193			0.6	193.6	20.0
17											193				193.0	20.0
18						0.2		2.3	0.6		97				100.1	10.4
19					0.6									1.8	2.4	1.6
20						5.3		4.2	14.2						23.7	15.3
21	0.1					1.1	0.1	6.6	2.9						10.8	7.0
22						0.7	0.1	4.5	1.7						7.0	4.5
23						0.4			1.1					0.8	2.3	1.5
24	0.1						0.1	4.3	0.1					1.5	6.1	3.9
25						0.3		4.7	0.9					1.5	7.4	4.8
26						0.2			0.6					0.8	1.6	1.0
27		1.7	135												136.7	88.5
28		8.6	27			5.5			14.7					1.8	57.6	37.3
29	4.0		263	0.6		11.1	4.8	7.6	29.6		186				506.7	52.5
30						0.7			1.9		97				99.6	10.3
31					0.3			4.9	0.1					0.9	6.2	4.0
32					0.2	2.9	0.1	2.0	7.6					2.1	14.9	9.6
33					8.3	0.5		2.4	1.4					5.3	17.9	11.6
34					16.6	1.0		2.4	2.7					1.5	24.2	15.7
35					8.3	1.8		2.3	4.8					0.9	18.1	11.7
36	0.1					1.8	0.2	6.2	4.8						13.1	8.5
37	0.1					1.3	0.1	9.4	3.4						14.3	9.3
38						0.7			1.9						2.6	1.7
39		0.9				0.9			2.5						4.3	2.8
40		3.4	411			10.4		4.9	27.7		17	42		31.9	548.3	355.0
41																
42	0.1	0.9			0.5	0.5	0.1		1.3					1.7	5.1	3.3
43	0.1				16.6	8.4	0.1	3.8	39.2		121			73.1	252.3	169.8
44	1.1			0.2	8.3	9.6	1.3	1.2	32.7						54.4	35.2
45	1.9			0.3		2.3	2.3	7.7	6.1						20.6	13.3
46	0.4			0.1		1.4	0.5	5.4	3.7					149.0	160.5	103.9
47	0.3					1.2	0.4	11.6	3.2						16.7	10.8
48	0.8		130	0.1		1.3	0.9	1.8	3.5						138.4	89.6
49	0.7			0.1		8.9	0.8	2.8	23.8						37.1	24.0
50						0.7			1.8		15	59		9.6	86.1	55.7
51											363				363.0	37.6
52	3.1	9.4	942	0.5		2.3	3.7	4.7	6.0		302	529		161.0	1963.7	203.4
53											218				218.0	22.6
54											73				73.0	7.6
55	0.5			0.1		0.9	0.6	4.9	2.5					41.0	50.5	32.7

Table 1.2 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1975

(ton/yr)

	Stationary				Mobile			Fugitive dust									
Grid	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.	Total ton/yr	Emiss. dens. ton/ mi^2/yr
56	0.2	1.7			0.5	5.6	0.2	0.8	14.9					20.7	44.6	28.9
57	2.5			0.4		17.1	3.0	0.9	37.5	13.6	10			37.8	122.8	79.5
58	2.4			0.4		18.5	3.0	11.5	49.4						85.2	55.2
59	2.3			0.3		11.5	2.8	7.9	30.8					171.0	226.6	146.7
60	0.7			0.1		6.7	0.8	17.8	18.0					171.0	215.1	139.3
61	2.5			0.4		6.5	3.0	11.0	17.4						40.8	26.4
62	3.3			0.5		14.0	4.0	2.7	37.5					144.9	206.9	134.0
63	0.5			0.1		2.4	0.6	5.0	6.5						15.1	9.8
64																
65	0.7			0.1		2.2	0.9	9.9	5.9						19.7	12.[illegible]
66	1.0	3.4	6	0.1	0.2	8.7	1.2	2.3	23.3		12			0.8	59.0	38.2
67	1.6	1.7		0.2	0.2	31.3	1.9	3.1	83.5					11.5	135.0	87.4
68	5.5			0.8		13.5	6.6	1.7	32.6	5.9				22.9	89.5	58.0
69	1.2			0.2		15.1	1.4	15.2	40.3						73.4	47.5
70	2.2			0.3		3.1	2.7	4.0	8.2					52.2	72.7	47.1
71	3.2			0.5		11.8	3.8	1.4	31.5					59.0	111.2	72.0
72	0.7			0.1		5.8	0.9	7.1	15.6						30.2	19.6
73							0.1						90		90.1	58.3
74																
75											169				169.0	17.5
76	8.7			1.3		7.5	10.4	13.1	20.0		193			62.7	316.7	32.8
77	1.8			0.3		7.9	2.2	21.1	21.0						54.3	35.2
78	2.9	0.9		0.4		9.9	3.5	9.6	25.4					66.9	120.5	78.0
79	1.2	1.7		0.2	1.1	28.6	1.5	4.5	76.5					73.5	188.8	122.2
80	3.1			0.5		33.8	3.7	4.6	75.1	24.4				70.9	216.1	139.9
81	4.1			0.6		23.0	5.0	3.8	61.6						98.1	63.5
82	3.9			0.6		19.8	4.7	11.6	52.9		10			30.9	134.4	87.0
83	2.1			0.3		9.1	2.6	2.6	24.3						41.0	26.5
84	0.7			0.1		4.0	0.8	2.6	10.6						18.8	12.2
85		3.4	871									69	90	7.8	1041.2	674.2
86		1.7	130												131.7	85.3
87											121				121.0	12.5
88											24				24.0	2.5
89	2.8			0.4		12.0	3.4	10.1	32.0						60.7	39.3
90	2.7			0.4		11.4	3.3	3.4	30.5		19			96.6	167.3	108.3
91	2.1	2.6	7	0.3	0.7	16.0	2.5	7.9	42.8		11			153.8	246.7	159.7
92	3.7	1.7		0.6	0.2	45.6	4.5	0.4	121.8		116			88.2	382.7	247.8
93	4.0			0.6		31.9	4.9	2.1	85.2		24			48.3	201.0	130.1
94	2.5			0.4		8.3	3.0	3.4	22.1					44.4	84.1	54.5
95	1.2			0.2		3.4	1.4	34.2	9.1					11.5	61.0	39.5
96	0.5	0.9		0.1		3.0	0.6	4.8	7.9					27.5	45.3	29.3
97		1.7	32			0.2			0.6						34.5	22.3
98																
99	3.2			0.5		12.5	3.8	3.8	33.4						57.2	37.0
100	1.4			0.2		9.8	1.7	2.2	26.3					5.5	47.1	30.5
101	2.3			0.3		13.0	2.8	3.2	34.7		2			100.6	158.9	102.9
102	3.1	2.6	5	0.5	0.5	35.1	3.8	11.6	93.8			11		43.3	210.3	136.2
103	4.8			0.7		18.5	5.8	1.1	49.5		72			54.1	206.5	133.7
104	2.5			0.4		6.5	3.1	18.0	17.3					16.3	64.1	41.5
105	1.6			0.2		3.6	1.9	7.9	9.5						24.7	16.0
106	0.7			0.1		3.7	0.9	2.2	9.8					52.7	70.1	45.4
107						0.2			0.4						0.6	0.4
108	1.3						0.2	1.1							2.6	1.7
109											48				48.0	5.0
110	4.5			0.7		1.8	5.4	12.4	4.9		268			120.0	417.7	43.3

Table 1.2 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1975

(ton/yr)

	Stationary				Mobile			Fugitive dust									
Grid	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.	Total ton/yr	Emiss. dens. ton/ mi^2/yr
111						0.1			0.4		169				169.5	17.6
112											97				97.0	10.0
113	2.7			0.4		4.8	3.2	6.7	12.9						30.7	19.9
114	2.1			0.3		1.9	2.5	10.5	5.0						22.3	14.4
115	4.5			0.7		4.0	5.4	2.5	10.8						27.9	18.1
116	4.6	1.7		0.7	0.5	7.1	5.5	11.6	18.9		22			8.1	80.7	...3
117	5.3			0.8		19.1	6.4	4.0	50.9					75.1	161.6	104.6
118	3.9			0.6		12.9	4.8	13.1	34.3						69.6	45.1
119	1.2			0.2		4.1	1.5	21.9	11.0						39.9	25.8
120	0.7			0.1		4.3	0.9	17.4	11.6						35.0	22.7
121				0.1		2.0		2.5	5.4						10.0	6.5
122						0.3			0.7						1.0	0.6
123	0.8			0.1	0.7	7.3	0.9	4.4	19.4						33.6	21.8
124	0.8			1.0	1.4	0.4	1.0	1.6	1.1						7.3	4.7
125	2.4			1.3		1.2	2.9	1.8	3.3		5			45.1	63.0	40.8
126	1.8	0.9		1.2		0.7	2.1	1.4	1.9						10.0	6.5
127	5.6	1.7		0.8	0.4	8.3	6.7	8.2	22.2					1.2	55.1	35.7
128	3.2			0.5		5.9	3.8	1.4	15.6						30.4	19.7
129	0.9			0.1		4.1	1.1	0.4	10.9						17.5	11.3
130	0.4			0.1		0.8	0.4	6.3	2.3						10.3	6.7
131	0.6			0.1			0.7	16.4							17.8	11.5
132																
133											290				290.0	30.0
134	0.8			1.9		5.7	0.9	6.9	14.9		242				273.1	28.3
135	0.2			6.3		1.9	0.3	7.5	5.0						21.2	2.2
136	0.6			3.7	0.6	1.2	0.7	8.6	3.3					1.8	20.5	2.1
137	3.3	0.9		0.5	1.0	14.0	4.0	5.0	37.5					3.2	69.4	7.2
138	2.4	1.7		0.4	11.6	5.3	2.9	2.0	14.2			1		20.4	61.9	6.4
139																
140																
141	0.2					2.7	0.2		7.3		97				107.4	11.1
142	0.1					1.9	0.1	8.8	5.0		314				329.9	34.2
143				8.2					0.1						8.3	0.9
144				3.6							121				124.6	12.9
145			9		0.9						73			2.3	85.2	8.8
146	0.4		18	0.1	1.4	2.7	0.5	0.8	7.2		145			4.4	180.5	18.7
147					0.3	0.9			2.5		73			1.0	77.7	8.0
148											73				73.0	7.6
Tot.	171.6	55.8	2986.0	51.9	85.3	795.7	206.8	621.4	2122.7	43.9	5818.0	711.0	180.0	2641.0	16491.1	

Table 1.3. EMISSION SUMMARY BY GRID, LAS VEGAS 1980

(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens, ton/mi^2/yr
	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.		
1											121				121.0	12.5
2					1.1						121			3.0	125.1	13.3
3					1.0	2.0			7.4		48			2.5	60.9	6.4
4						1.5			5.5		97				104.0	10.9
5																
6																
7						0.4			1.7		97				99.1	10.4
8						3.6			13.3					4.1	21.0	2.2
9											218			3.8	221.8	23.0
10	0.2				1.4	0.6	0.3	5.4	2.2		121			16.3	147.4	15.3
11					0.5	13.8			50.5					1.2	66.0	6.9
12	0.7			0.1		1.9	0.8	5.3	7.1		218				233.9	24.2
13	0.2					3.5	0.3	5.5	13.0						22.5	2.3
14	0.2				0.1	2.1	0.3	5.7	7.9					26.4	42.7	4.4
15	5.4			0.8	0.1	12.3	6.5	14.1	44.9		82			66.9	233.1	24.1
16						1.0			3.6		193			0.6	198.2	20.5
17											193				193.0	20.0
18	0.1					0.7	0.1	2.6	2.5		97				103.0	10.7
19														1.8	1.8	1.2
20	0.2				0.7	4.2	0.3	5.3	15.5						26.2	17.0
21	0.4					1.7	0.4	7.5	6.2						16.2	10.5
22	0.2					1.8	0.3	5.5	6.7						14.5	9.4
23						1.4			5.4					0.8	7.6	4.9
24	0.2					1.1	0.3	4.9	4.2					1.5	12.2	7.9
25	0.2					0.7	0.3	5.3	2.8					1.5	10.8	7.0
26						1.0			3.6					0.8	5.4	3.5
27		1.9	149			0.9			3.4						155.2	100.5
28		9.5	30			5.7			21.4					1.8	69.4	44.3
29	4.3		290	0.7		9.9	5.2	8.6	37.1		186				541.9	56.1
30						0.7			2.5		97				100.2	10.4
31	0.2				0.4	0.2	0.3	5.6	0.7					0.9	8.3	5.4
32	0.1				0.2	4.3	0.2	2.3	16.1					2.1	25.3	16.4
33	0.1				9.4	1.3	0.1	2.7	5.0					5.3	23.9	15.5
34	0.1				18.8	2.3	0.1	2.7	8.4					1.5	33.9	22.0
35	0.1				9.4	3.3	0.1	2.6	12.3					0.9	28.7	18.6
36	0.4					3.5	0.5	7.0	13.2						24.6	15.9
37	0.4					2.8	0.5	10.7	10.4						24.8	16.1
38						1.8			6.7						8.5	5.5
39		0.9				1.7			6.2						8.8	5.7
40	0.2	3.8	454			10.8	0.3	5.5	39.3		17	42		31.9	604.8	391.6
41						0.1			0.4						0.5	0.3
42		9.5			0.6	1.0			3.6					1.7	16.4	10.6
43	0.3				18.8	10.5	0.3	4.3	38.2		121			73.1	266.5	172.6
44	1.1			0.2	9.4	8.8	1.4	1.4	32.7						55.0	35.6
45	2.2			0.3		3.2	2.6	8.8	11.9						29.0	18.8
46	0.6			0.1		2.4	0.8	6.2	8.8					149.0	167.9	108.7
47	0.8					2.5	1.0	13.2	9.3						26.8	17.4
48	0.8		144	0.1		1.8	1.0	2.1	6.8						156.6	101.4
49	0.8			0.1		9.0	1.0	3.1	33.8						47.8	31.0
50						0.6			2.1		15	59		9.6	86.3	55.9
51						0.1			0.4		363				363.5	37.7
52	3.3	10.4	1030	0.5		4.1	4.0	5.3	15.1		302	529		161.0	2072.7	214.7
53						2.8			10.6		218				231.4	24.0
54											73				73.0	7.6
55	0.7			0.1		2.7	0.8	5.5	10.1					41.0	60.9	39.4

Table 1.3 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1980

(ton/yr)

	Stationary				Mobile			Fugitive dust								
Grid	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.	Total ton/yr	Emiss. dens. ton/ mi²/yr
56	0.2	1.9			0.6	8.7	0.2	2.0	32.6					20.7	66.9	43.3
57	2.5			0.4		17.9	3.1	1.1	66.0		10			30.3	131.3	85.0
58	2.9			0.4		13.2	3.5	13.1	48.4						81.5	52.8
59	2.6			0.4		9.6	3.2	9.0	35.7					136.8	197.3	127.8
60	1.4			0.1		6.6	1.7	20.2	24.5					136.8	191.3	123.9
61	2.9			0.4		6.0	3.6	12.5	22.6						48.0	31.1
62	3.4			0.6		13.9	4.1	3.1	50.8					144.9	220.8	143.0
63	0.7			0.1		4.4	0.8	5.7	16.5						28.2	18.3
64						2.5			9.2						11.7	7.6
65	1.1			0.1		4.8	1.4	11.3	17.9						36.6	[illegible]
66	1.0	3.8	7	0.2	0.2	13.7	1.3	2.6	50.1		12			0.8	92.7	60.0
67	1.7	1.9		0.3	0.2	23.6	2.1	3.5	87.2					9.4	129.9	84.1
68	5.5			0.9		9.7	6.7	2.0	36.2					18.3	79.3	51.3
69	1.8			0.2		10.9	2.2	17.4	39.8						72.3	46.8
70	2.4			0.4		5.0	2.9	4.5	18.6					41.8	75.6	49.0
71	3.2			0.5		12.1	3.9	1.6	44.3					59.0	124.6	80.7
72	1.0			0.1		7.5	1.3	8.1	28.2						46.3	30.0
73						1.5			5.7				90		97.2	63.0
74						0.1			0.5		169				169.6	17.6
75	9.1			1.5		15.3	11.1	14.9	56.1		193			62.7	363.7	37.7
76	2.6			0.3		8.2	3.2	23.9	12.5						50.7	32.8
77	3.2	0.9		0.5		9.0	3.9	10.9	33.4					66.9	128.7	83.3
78	1.4	1.9		0.2	1.4	26.6	1.7	5.1	98.4					63.0	199.7	129.3
79	3.3			0.5		25.9	4.0	5.2	95.8					56.7	191.4	123.9
80	4.2			0.7		19.7	5.2	4.4	72.7						106.9	69.2
81	3.9			0.7		17.0	4.7	10.0	62.5		10			24.7	133.5	86.4
82	2.2			0.4		11.7	2.7	2.9	42.8						62.7	40.6
83	0.8			0.1		4.0	1.0	3.0	15.1						24.0	15.5
84		3.8	962			1.3			5.0			69	90	7.8	1138.9	737.6
85		1.9	144												145.9	94.5
86											121				121.0	12.5
87											24				24.0	2.5
88	3.2			0.5		13.0	3.9	11.5	47.5						79.6	51.5
89	2.9			0.5		11.5	3.5	3.9	42.1		19			96.6	180.0	116.6
90	2.4	2.8	8	0.4	0.9	15.4	2.9	9.0	56.4		11			125.2	234.4	151.8
91	3.7	1.9		0.6	0.2	40.1	4.5	0.5	148.6		116			88.2	404.3	261.8
92	4.1			0.7		29.7	5.0	2.3	110.1		24			38.6	214.5	138.9
93	2.6			0.4		13.1	3.2	3.9	47.8					36.1	107.1	69.3
94	2.6			0.2		6.7	3.1	39.0	25.2					11.5	88.3	57.2
95	0.7	0.9		0.1		4.9	0.8	5.5	18.4					27.5	58.8	38.1
96		1.9	35			1.0			3.8						41.7	27.0
97						0.5			1.9						2.4	1.6
98	3.3			0.5		18.2	4.0	4.4	67.1						97.5	63.1
99	1.5			0.2		13.8	1.9	2.5	50.6					5.5	76.0	49.2
100	2.4			0.4		19.8	2.9	3.6	72.9		2			81.7	185.7	120.2
101	3.6	2.8	6	0.5	0.6	39.7	4.4	13.3	147.2			11		42.7	271.8	176.0
102	4.9			0.8		17.6	5.9	1.2	64.8		72			45.7	212.9	137.9
103	3.3			0.4		8.0	4.0	20.4	29.8					13.0	78.9	51.1
104	1.9			0.3		4.5	2.3	9.0	16.8						34.8	22.5
105	0.8			0.1		4.6	1.0	2.5	17.3					52.7	79.0	51.2
106						1.3			4.8						6.1	4.0
107	0.2					0.7	0.2	1.2	2.7						5.0	3.9
108											48				48.0	5.0
109	5.0			0.8		16.4	6.0	14.1	60.1		268			120.0	490.4	50.8
110						0.2			0.6		169				169.8	17.6
111																

Table 1.3 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1980

(ton/yr)

	Stationary				Mobile			Fugitive dust								
Grid	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.	Total ton/yr	Emiss. dens. ton/ mi^2/yr
112											97				97.0	10.0
113	2.9			0.5		7.3	3.6	7.6	27.3						49.2	31.9
114	2.5			0.4		8.8	3.0	11.9	32.9						59.5	38.5
115	4.5			0.8		6.7	5.5	2.9	24.9						45.3	29.3
116	5.0	1.9		0.8	0.6	9.1	6.1	13.2	34.1		22			8.1	100.9	65.3
117	5.4			0.9		17.4	6.6	4.5	63.9					75.1	173.8	112.5
118	4.5			0.7		12.0	5.4	15.0	44.0						81.6	52.8
119	2.1			0.2		4.2	2.6	25.0	15.6						49.7	32.2
120	1.4			0.1		4.7	1.7	19.8	17.6						45.3	29.3
121	0.1			0.1		2.1	0.1	2.8	7.8						13.0	8.4
122						1.0			3.6						4.6	3.0
123	0.9			0.1	0.8	8.1	1.1	5.0	30.3						46.3	30.0
124	0.9			1.0	1.6	1.5	1.0	1.8	5.5						13.3	8.6
125	2.5			0.4		4.5	3.0	2.0	16.9		5			45.1	79.4	51.4
126	1.8	0.9		1.2		2.0	2.2	1.6	7.6						17.3	11.2
127	5.6	1.9		1.0	0.5	12.2	7.2	9.3	44.7					1.2	83.6	54.1
128	3.2			0.5		5.4	3.9	1.6	20.3						34.9	22.6
129	0.9			0.2		4.3	1.1	0.5	16.0						23.0	14.9
130	0.6			0.1		1.7	0.7	7.1	6.4						16.6	10.7
131	1.2			0.1		0.7	1.5	18.7	2.5						24.2	15.7
132																
133											290				290.0	30.0
134	1.0			1.9		24.6	1.3	7.8	90.9		242				369.5	38.3
135	0.5			6.3		10.5	0.7	8.5	38.0						64.5	6.7
136	1.0			3.7	0.7	0.9	1.2	9.8	3.4					1.8	22.5	2.3
137	3.5	0.9		0.6	1.2	21.1	4.2	5.7	77.9					3.2	118.3	12.3
138	2.5	1.9		0.4	9.8	5.2	3.0	2.3	19.3			1		20.4	65.8	6.8
139																
140																
141						6.3			23.6		97				126.9	13.2
142	0.5					10.7	0.6	10.0	39.1		314				374.9	38.8
143				8.2		2.1			7.8						18.1	1.9
144				3.6							121				124.6	12.9
145			10		1.1						73			2.3	86.4	9.0
146	0.4		20	0.1	1.7	2.6	0.5	0.9	6.1		145			4.4	181.7	18.9
147					0.4	2.8			13.6		73			1.0	90.8	9.4
148											73				73.0	7.6
TOT.	194.0	61.6	3297.0	55.2	94.4	945.7	236.3	705.8	3477.6		5818.0	711.0	180.0	2439.2	18215.8	

Table 1.4. EMISSION SUMMARY BY GRID, LAS VEGAS 1985

(ton/yr)

	Stationary				Mobile			Fugitive dust								
Grid	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Oth. fugit. sourc.	Total ton/yr	[illegible] ton/yr
1											121				121.0	18.0
2					1.3						121			3.0	125.3	18.8
3					1.2	2.1			9.6		48			2.5	63.4	6.6
4						1.9			8.9		97				107.8	15.2
5																
6																
7						0.7			3.2		97				100.9	14.5
8						2.9			13.5					6.1	22.5	3.3
9											218			3.6	221.6	33.0
10	0.5				1.6	0.5	0.6	6.2	2.2		121			16.2	148.8	19.4
11					0.6	14.8			69.1					1.2	85.7	8.8
12	0.9			0.1		2.2	1.1	6.1	10.5		218				238.9	34.8
13	0.5					4.4	0.6	6.3	20.7						32.5	3.4
14	0.5				0.1	2.3	0.6	6.6	10.8					28.4	49.3	6.8
15	6.1			1.0	0.1	16.4	2.4	16.2	76.7		82			65.9	266.8	47.7
16						1.6			7.3		193			8.4	210.3	31.4
17											193				193.0	29.0
18	0.2					1.0	0.3	3.0	4.4		97				105.9	15.0
19					0.9									1.8	2.7	1.7
20	0.5					3.6	0.6	6.1	16.9						27.7	17.8
21	0.7					2.0	0.9	8.6	9.5						21.7	16.1
22	0.5					2.5	0.6	5.9	11.7						21.2	16.7
23						2.1			9.6					0.8	12.5	8.1
24	0.5					1.8	0.6	5.6	8.3					1.5	18.3	11.0
25	0.5					1.0	0.6	6.1	4.7					3.0	15.9	9.2
26						1.4			6.6					0.8	8.8	5.7
27		2.1	165			1.5			6.8						175.4	113.4
28		10.5	33			6.0			28.0					1.8	79.3	31.4
29	4.7		321	0.8		15.9	5.7	9.9	74.0		166				598.0	65.0
30						0.6			3.0		97				100.6	18.6
31	0.5				0.4	0.3	0.6	6.4	1.4					0.9	10.5	6.6
32	0.2				0.3	5.3	0.3	2.7	24.7					2.1	35.6	23.1
33	0.2				10.6	1.8	0.3	3.1	8.6					5.3	29.9	18.4
34	0.2				21.3	3.0	0.3	2.2	14.1					3.6	44.7	28.2
35	0.2				10.6	4.2	0.3	3.0	19.8					8.8	46.9	25.3
36	0.7					4.6	0.9	8.1	21.5						35.8	23.2
37	0.9					3.7	1.1	12.3	17.4						35.4	20.0
38						2.4			11.4						13.8	8.8
39		1.1				2.1			9.9						13.1	8.5
40	0.5	4.2	501			11.3	0.6	6.4	52.9		17	42		25.9	661.8	430.6
41						0.2			0.8						1.0	0.7
42		1.1			0.7	1.3			6.0					1.7	10.8	2.6
43	0.5				21.4	12.0	0.6	4.9	55.0		121			73.1	288.5	187.3
44	1.2			0.2	10.6	8.6	1.4	1.6	37.9						61.5	41.1
45	2.6			0.4		3.8	3.1	10.1	17.7						37.7	28.4
46	0.9			0.1		3.0	1.1	7.1	13.9					148.0	174.1	112.6
47	1.4					3.3	1.7	15.2	15.5						37.1	28.2
48	0.9		158	0.2		2.2	1.4	2.4	10.1						175.2	113.4
49	0.9			0.1		9.4	1.4	3.6	43.0						58.4	25.3
50						0.5			2.3		15	60		8.6	86.4	35.9
51						0.2			0.8		363				364.0	37.7
52	3.5	11.5	1143	0.6		5.2	4.3	6.1	24.2		302	470		161.0	2131.4	227.4
53						4.5			21.2		218				243.7	35.7
54											73				73.0	7.6
55	0.9			0.1		3.8	1.4	6.4	17.7					41.0	71.3	40.2
56	0.2	2.1			0.7	10.7	0.3	1.1	50.1					26.7	91.9	50.6

Table 1.4 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1985

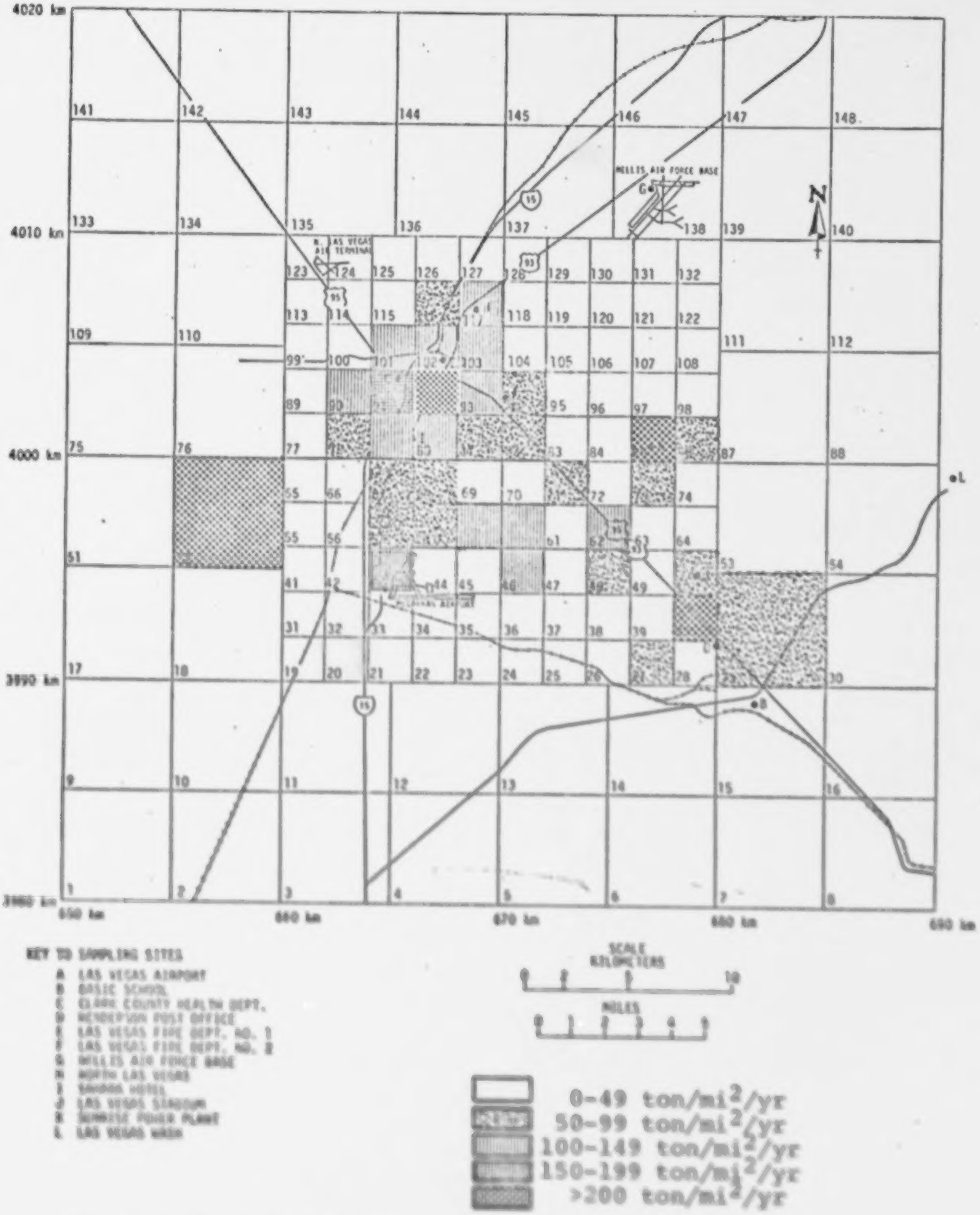
(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens. ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Contr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
57	2.6			0.5		10.9		1.2	88.2		10			22.8	144.2	93.4
58	2.5			0.8		10.6	3.1	15.1	40.4						82.2	53.2
59	3.0			0.5		8.4	3.7	10.4	39.0					102.6	167.6	108.5
60	2.3			0.1		6.6	2.9	22.3	31.0					102.6	167.8	108.7
61	3.8			0.8		6.0	4.3	14.4	27.8						56.9	36.6
62	3.5			0.6		14.2	4.3	3.5	66.3					144.9	237.2	153.7
63	0.9			0.1		5.7	1.4	6.5	26.6						41.2	26.7
64						3.9			18.4						22.3	14.4
65	1.6			0.1		4.4	2.0	13.0	29.9						53.0	34.3
66	1.2	4.2	7	0.2	0.3	16.9	1.4	3.0	78.9		12			0.8	125.9	81.
67	1.9	2.1		0.3	0.3	10.5	2.3	4.0	92.6					7.2	130.8	84.7
68	0.6			1.1		7.8	6.8	2.3	38.2					13.8	73.6	47.7
69	2.6			0.2		8.6	3.1	19.0	41.1						74.8	48.4
70	2.6			0.4		6.2	3.1	5.2	29.1					31.3	77.9	50.4
71	3.3			0.6		12.7	4.0	1.8	58.2					60.0	140.6	91.0
72	1.4			0.1		8.7	1.7	9.3	40.8						62.1	40.2
73						2.6			11.4				90		103.9	67.3
74																
75						0.2			0.9		169				170.1	17.6
76	9.8			1.7		20.2	12.0	17.2	54.2		193			62.7	410.8	42.6
77	3.7			0.3		8.6	4.6	25.1	40.0						83.3	53.9
78	3.7	1.1		0.6		8.7	4.6	12.6	72.3					66.9	170.5	110.4
79	1.6	2.1		0.2	1.6	20.2	2.0	5.9	122.3					92.9	214.4	138.8
80	3.5			0.6		22.1	4.3	6.0	103.3					42.5	182.3	118.0
81	4.4			0.8		18.4	3.4	5.0	85.9						119.9	77.6
82	3.9			0.8		15.9	4.7	5.5	74.2		10			18.5	130.8	85.1
83	2.3			0.4		13.5	2.9	3.3	63.0						85.4	55.3
84	0.9			0.1		4.2	1.1	3.4	19.5						29.2	18.9
85		4.8	1062			2.1			10.0			60	80	7.8	1245.1	806.2
86		2.1	166												168.1	108.7
87											121				121.0	12.5
88											24				24.0	2.5
89	3.7			0.6		13.9	4.6	13.3	66.9						101.0	65.4
90	3.0			0.5		11.9	2.7	4.4	53.7		19			95.6	194.8	126.1
91	2.8	3.1	9	0.4	1.0	15.4	2.4	10.4	71.9		11			95.6	225.0	145.7
92	3.7	2.1		0.7	0.3	30.2	4.6	0.5	140.5		116			80.2	432.0	280.2
93	4.2			0.8		28.4	5.1	2.7	137.0		24			29.0	232.2	150.3
94	2.8			0.5		16.2	3.4	4.5	75.5					27.8	130.7	84.6
95	1.0			0.2		8.9	2.2	41.4	41.3					11.5	107.2	69.5
96	0.9	1.1		0.1		6.7	1.1	2.3	28.7					27.5	71.8	46.6
97		2.0	20			1.6			7.0						40.6	27.1
98						1.0			3.0						4.1	3.0
99	3.5			0.6		20.0	4.3	5.0	102.6						136.0	88.0
100	1.6			0.3		36.1	2.0	2.5	77.0					5.5	125.0	80.5
101	2.6			0.4		24.2	3.1	4.1	112.0		3			52.8	209.1	135.6
102	4.2	3.1	6	0.6	0.7	43.5	5.1	15.3	203.0			11		42.0	334.5	216.6
103	6.0			0.8		57.6	6.0	1.4	60.3		70			87.3	222.4	144.0
104	4.2			0.5		9.0	5.1	22.5	42.2					9.8	93.3	60.4
105	2.3			0.3		6.5	2.0	10.3	26.2						46.6	30.1
106	0.9			0.1		6.3	1.1	2.9	26.7					52.7	87.2	56.6
107						2.0			9.2						11.2	7.3
108	0.5					1.0	0.3	1.6	5.6						8.6	5.6
109											40				40.0	3.0
110	3.6			0.9		25.1	4.8	36.3	117.1		600			100.0	888.0	58.0
111						0.2			0.6		500				500.8	50.6
112											97				97.0	10.0

Table 1.4 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1985

(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens., ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail/air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
113	3.3			0.5		9.0	4.0	8.7	41.8						67.3	43.6
114	3.0			0.4		13.0	3.7	13.8	60.7						94.6	61.3
115	4.7			0.9		8.3	5.7	3.3	38.9						61.6	40.0
116	5.6	2.1		0.9	0.7	10.5	6.8	15.2	49.2		22			8.1	120.9	78.3
117	5.6			1.0		16.9	6.8	5.2	78.8					75.1	189.4	[illegible]
118	5.1			0.8		12.0	6.3	17.2	55.8						97.2	62.9
119	3.3			0.2		4.4	4.0	27.3	20.3						59.5	38.5
120	2.3			0.1		5.0	2.9	21.8	23.5						55.6	36.0
121	0.2			0.1		2.2	0.3	3.2	10.3						16.3	10.6
122						1.4			6.6						8.0	5.2
123	1.2			0.2	0.9	8.8	1.4	6.8	41.1						59.4	38.5
124	0.9			1.1	1.9	2.1	1.1	2.1	10.0						19.2	12.4
125	2.6			1.4		6.5	3.1	2.3	30.5		5			45.1	96.5	62.5
126	1.9	1.1		1.2		2.9	2.3	1.8	13.4						24.6	15.9
127	6.3	2.1		1.1	0.6	14.8	7.7	10.7	69.3					1.2	113.8	73.7
128	3.3			0.6		8.4	4.0	1.9	25.0						39.9	25.8
129	0.9			0.2		4.5	1.1	0.5	21.0						28.0	18.1
130	0.9			0.1		2.3	1.1	8.2	10.6						23.2	15.0
131	2.1			0.1		1.1	2.6	20.6	5.0						31.5	20.4
132																
133											290				290.0	30.0
134	1.4			2.0		36.1	1.7	9.0	166.7		242				460.9	47.7
135	0.9			6.3		18.6	1.1	9.8	73.0						108.7	11.1
136	1.4			3.7	0.9	0.8	1.7	11.3	36.0					1.8	57.6	6.0
137	3.7	1.1		0.6	1.4	25.8	4.6	6.5	120.4					3.2	167.3	17.3
138	2.6	2.1		0.5	0.8	5.2	3.1	2.6	24.3			1		29.4	71.6	7.4
139																
140																
141						8.6			39.9		97				145.5	15.1
142	0.9					16.1	1.1	11.5	73.1		316				418.7	43.4
143				8.2		3.3			15.6						27.1	2.8
144				3.6							121				124.6	12.9
145			11		1.3						73			2.3	87.6	9.1
146	0.5		22	0.1	2.0	3.5	0.6	1.0	8.8		145			4.4	184.2	19.2
147					0.4	2.8			24.7		73			1.8	101.6	10.5
148											73				73.0	7.6
Tot.	[illegible]	44.0	3641.0	59.2	106.5	1766.1	173.8	785.7	1529.5		5018.0	711.0	100.0	2737.5	21775.2	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N. LAS VEGAS AIR TERMINAL
NELLIS AIR FORCE BASE
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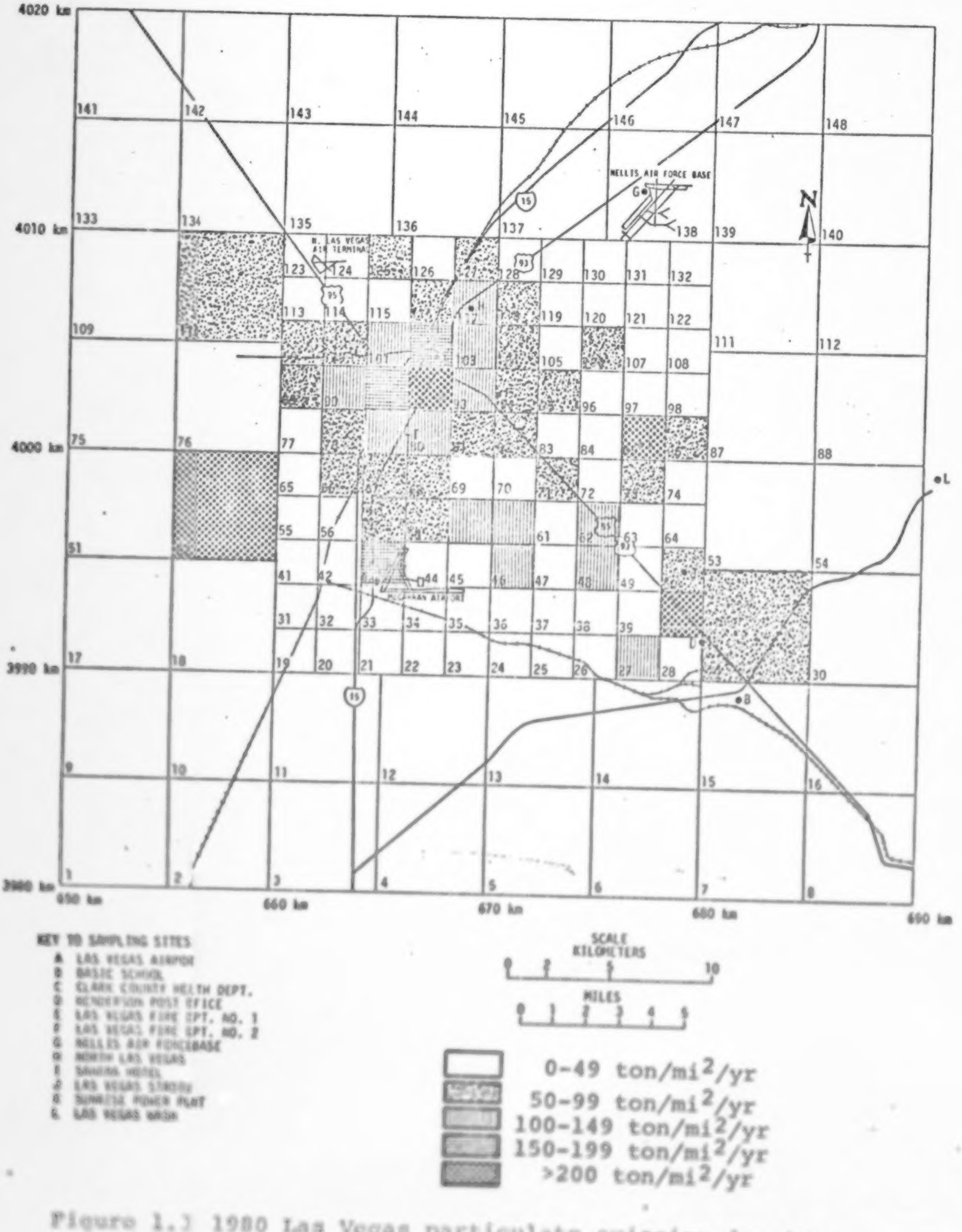
KEY TO SAMPLING SITES
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
0-49 ton/mi²/yr
50-99 ton/mi²/yr
100-149 ton/mi²/yr
150-199 ton/mi²/yr
>200 ton/mi²/yr

Figure 1.2 1975 Las Vegas particulate emission density. ton/mi^2/yr.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4010 km
4000 km
3990 km
3980 km
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NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
LAS VEGAS AIRPORT
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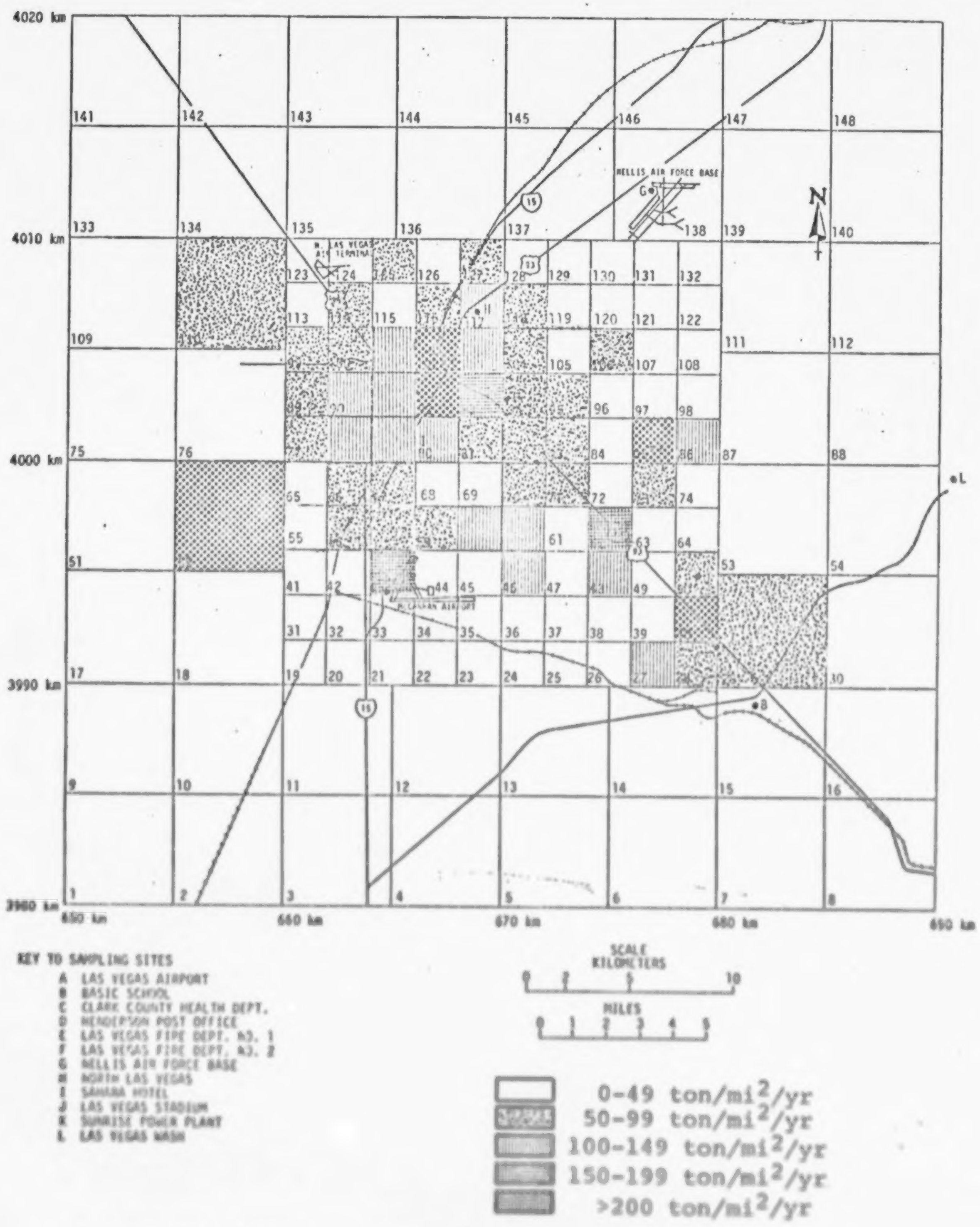
KEY TO SAMPLING SITES
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HELTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DPT. NO. 1
F LAS VEGAS FIRE DPT. NO. 2
G NELLIS AIR FORCEBASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
0-49 ton/mi²/yr
50-99 ton/mi²/yr
100-149 ton/mi²/yr
150-199 ton/mi²/yr
>200 ton/mi²/yr

Figure 1.3 1980 Las Vegas particulate emission density, ton/mi^2/yr.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4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
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NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
McCARRAN AIRPORT
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93
KEY TO SAMPLING SITES
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
0-49 ton/mi²/yr
50-99 ton/mi²/yr
100-149 ton/mi²/yr
150-199 ton/mi²/yr
>200 ton/mi²/yr

Figure 1.4 1985 Las Vegas particulate emission density, ton/mi^2/yr.

2. EMISSION CALCULATION PROCEDURES

In this Chapter, methods have been outlined for determining total annual area source emissions for all source categories in the Las Vegas Valley.

STATIONARY FUEL COMBUSTION

Residential fuel usage in the Las Vegas Valley was calculated using the "degree-day" method described in EPA publication APTD-1135 "Guide for Compiling a Comprehensive Emission Inventory."[2] The equation is

$$TF = (DD)(DU)(HF)(RDU/5.0) \tag{1}$$

where

TF = total quantity of a given type of fuel used residentially

DU = number of dwelling units using the given fuel in the locality

DD = number of heating degree-days in the locality

HF = heating requirement factor of the given fuel in quantity per dwelling unit-degree-day

RDU = average number of rooms per dwelling unit in the locality

5.0 = national average number of rooms per dwelling unit.

All factors used for fuel usage calculations are shown in Table 2.1.

In Las Vegas, air conditioners are also fueled by natural gas. Therefore, the number of cooling degree days

Table 2.1 FACTORS FOR FUEL USAGE AND EMISSIONS CALCULATIONS IN LAS VEGAS

		1975	1980	1985	Units
(DU) Dwelling units[1]	:Coal	0	0	0	
	Distillate oil	334	167	83	
	Residual oil	0	0	0	
	Natural gas	43,764	50,900	59,442	
	LPG	3,908	4,545	5,308	
	Wood	118	65	36	
(HF) Heating requirement factor (units per dwelling unit degree day[2])	:Coal	0.0012			tons
	Distillate oil	0.18			gallons
	Residual oil	0.18			gallons
	Natural gas*	25.93			cubic feet
	LPG*	0.29			gallons
	Wood	0.0017			tons
(DD) Degree days[3]	:Heating	2,526			
	Cooling	3,100			
(RDU) Rooms per dwelling unit[1]	:Clark County	4.6			
Population[4]	:Nevada	642,248			
	Las Vegas Valley	358,649	408,842	471,000	
Bureau of Mines Nevada fuel usage totals (1974) residential and commercial/institutional	:Coal[6]	2			10^3 tons
	Distillate oil[7]	19,656			10^3 gallons
	Residual oil[7]	3,444			10^3 gallons
	Natural gas[8]	23,466			10^6 cubic feet
	LPG[9]	23,626			10^3 gallons
Industrial	:Coal[6]	125			10^3 tons
	Distillate oil[7]	14,574			10^3 gallons
	Residual oil[7]	1,428			10^3 gallons
	Natural gas[8]	9,272			10^6 cubic feet
	LPG[9]	3,958			10^3 gallons
Clark Co. Pt. Source totals[10] - commercial/institutional	:Coal	0			
	Distillate oil	139			10^3 gallons
	Residual oil	0			
	Natural gas	0			
	LPG	2,634			10^3 gallons
Industrial	:Coal	0			
	Distillate oil	436			10^3 gallons
	Residual oil	4,140			10^3 gallons
	Natural gas	7,211			10^6 cubic feet
	LPG	0			

* These factors were calculated based on figures for the other fuels and their heat contents.

must be accounted for in addition to the heating degree days to determine total residential natural gas usage by this method. However, more accurate figures were available from the Southwest Gas Corporation[11] serving the Las Vegas Valley. For 1975 they reported 6,020 million cubic feet of natural gas sold to residential users.

Commercial/institutional fuel usage is determined by subtracting the residential usage in the Las Vegas Valley from the total of residential, commercial and institutional fuel usage in the Valley. Valley residential-commerical/institutional usage totals for each fuel type are obtained by multiplying the State fuel usage totals by the ratio of the Valley population to the State population. Commercial/institutional point source fuel usage totals for the Valley must be subtracted from the previously calculated Valley total in order to obtain the area source fuel usage totals. Point source fuel usage figures are available from the National Emission Data System[10] (NEDS) listings for Clark County.

The State totals for each fuel type are obtained from Mineral Industry Surveys, published by the U.S. Department of the Interior Bureau of Mines,[6,7,8,9] as follows:

Coal - "Bituminous Coal and Lignite Distribution, Calendar Year 1974."[6] The State total is the value for "Retail" in Table II.

Distillate Oil - "Sales of Fuel Oil and Kerosene: 1974."[7] The State total is the sum of the values "Kerosene Heating" in Table 5, "Distillate Heating" in Table 6, and Military Distillate" in Table 12.

Residual Oil - "Sales of Fuel Oil and Kerosene: 1974."[7] The State total is the sum of the values "Residual Heating" in Table 7 and "Military Residual" in Table 12.

Natural Gas - "Natural Gas Production and Consumption: 1974."[8] The State residential total is reported separately in Table 7. The State commercial/institutional total is the sum of the values "Commercial" and "Other," both in Table 7.

LPG - "Sales of Liquified Petroleum Gases and Ethane: 1974."[9] The State total is reported as "Residential and Commercial" in Table 2.

Wood - Currently there is no method for determining commercial/institutional wood usage.

These figures, representing the total amounts of each fuel type used residentially, commercially, and institutionally in the State of Nevada, are shown in Table 2.1. Again, it was felt that more accurate data on natural gas usage in the Las Vegas Valley were provided by Southwest Gas Corporation,[11] who reported 4,248 million cubic feet sold for commercial/institutional usage in 1975. Also the District Health Department of Clark County indicates that there was no significant coal usage in the Las Vegas Valley.[5]

Industrial fuel usage is determined in a similar manner. State totals for industrial fuel usage are obtained from Mineral Industry Surveys as follows:

Coal - "Bituminous and Lignite Distribution, Calendar Year 1974."[6] The State total is the sum of the values "Coke & Gas Plants" and "Other," both in Table II.

Distillate Oil - "Sales of Fuel Oil and Kerosene: 1974."[7] The State total is the sum of the values "Industrial Distillate" in Table 8 and "Oil Company Use Distillate" in Table 9.

Residual Oil - "Sales of Fuel Oil and Kerosene: 1974."[7] The State total is the sum of the values "Industrial Residual" in Table 8 and "Oil Company Use Residual" in Table 9.

Natural Gas - "Natural Gas Production and Consumption: 1974"[8] The State total is the value "Industrial" in Table 7.

LPG - "Sales of Liquified Petroleum Gases and Ethane: 1974"[9] The State total is the value "Industrial" in Table 2.

These State totals, shown in Table 2.1, are multiplied by the ratio of Valley manufacturing employees to State manufacturing employees in order to determine Valley fuel usage totals. Fuel usage by Valley industrial point sources must be subtracted from these calculated values to obtain the area source industrial fuel usage totals.

Southwest Gas Corporation[11] reported 9,494 million cubic feet of natural gas sold to industrial users in the Valley in 1975. No significant industrial area sources burn coal according to the District Health Department of Clark County.[5]

Residential, commercial/institutional and industrial particulate emissions from fuel combustion in the Las Vegas Valley are calculated by multiplying the total area source usage in the Valley by the appropriate emission factor[12] as shown in Table 2.2.

Projections - Emissions for the years 1980 and 1985 were calculated based on projections of fuel usage. Residential fuel usage was projected based on the number of dwelling units heating with each type of fuel. The number of dwelling units using each fuel type were projected based on historic trends. Commercial/institutional usage was projected based on population figures supplied by the Clark County Regional Planning Council.[4] Industrial usage was projected at a rate of 2 percent per year based on discussions with the Clark County District Health Department.[5] The projected emissions are shown in Table 2.3.

Table 2.2 STATIONARY FUEL COMBUSTION EMISSIONS FROM AREA SOURCES IN THE LAS VEGAS VALLEY FOR 1975

Fuel Category	Fuel Usage	Emission Factor	Emission (tons/year)
Residential:			
Coal	-	-	-
Distillate Oil	[illegible] gal	10 lb/10^3 gal	0.69
Residual Oil	-	-	-
Natural Gas	6,020 x 10^6ft^3	10 lb/10^6ft^3	30.10
LPG	2,634,745 gal	1.85 lb/10^3 gal	2.44
Wood	466 tons	17 lb/ton	3.96
Commercial/Institutional:			
Coal	-	-	-
Distillate Oil	10,836,736 gal	15 lb/10^3 gal	81.28
Residual Oil	1,923,224 gal	23 lb/10^3 gal	22.12
Natural Gas	4,248 x 10^5ft^3	10 lb/10^6ft^3	21.24
LPG	10,559,656 gal	1.85 lb/10^3 gal	9.77
Wood	-	-	-
Industrial:			
Coal	-	-	-
Distillate Oil	5,724,693 gal	15 lb/10^3 gal	42.94
Residual Oil	-	-	-
Natural Gas	2,283 x 10^6ft^3	10 lb/10^6ft^3	11.41
LPG	1,673,118 gal	1.75 lb/10^3 gal	1.46
Wood	-	-	-

Table 2.3 PROJECTED STATIONARY FUEL COMBUSTION EMISSIONS FROM AREA SOURCES IN THE LAS VEGAS VALLEY

	1975	1980	1985
Residential:			
Distillate Oil	0.69	0.35	0.17
Residual Oil	-	-	-
Natural Gas	30.10	35.01	40.88
LPG	2.44	2.84	3.31
Wood	3.96	2.18	1.21
Residential Total	37.19	40.38	45.57
Commercial/Institutional:			
Distillate Oil	81.28	92.90	107.21
Residual Oil	22.12	25.28	29.18
Natural Gas	21.24	24.28	28.02
LPG	9.77	11.17	12.89
Commercial/Institutional Total	134.41	153.63	177.30
Industrial:			
Distillate Oil	42.94	47.41	52.34
Residual Oil	-	-	-
Natural Gas	11.41	12.60	13.91
LPG	1.46	1.61	1.78
Industrial Total	55.81	66.62	68.03

Allocations - Residential and commercial/institutional emissions were allocated to grids by population. Industrial emissions were allocated to grids based on the location of industrial areas indicated on a regional land use map provided by the Clark County Regional Planning Council.[30]

Further explanation of projections and allocations by population is given in Section 3.

INDUSTRIAL PROCESSES

Most industrial processes which have significant emissions have been indicated as point sources on National Emissions Data System (NEDS) forms.[10] Total emissions for this category were taken from these forms for Las Vegas which amounted to 2,986 tons/year.

Projections - Emissions were projected to increase at a rate of 2 percent per year based on conversations with the Clark County District Health Department.[5] The growth factors and emissions are shown in Table 2.4.

Table 2.4 INDUSTRIAL PROCESSES EMISSIONS FOR LAS VEGAS

	1975	1980	1985
Growth factor	-	1.104	1.219
Emissions (tons/year)	2,986	3,297	3,640

Allocations - Emissions were allocated to grids based on the UTM coordinates of each source obtained from the NEDS forms.[10] A list of these sources is given in Appendix A.

BURNING

In this category emissions from wildfires, structural fires, controlled burning, and incineration were determined for the Las Vegas Valley. The following offices were contacted to obtain the required information: The Bureau of Land Management,[13] the U.S. Forest Service,[14] and the fire departments of Clark County (including Las Vegas),[15] and North Las Vegas.[16] These agencies reported a combined total of 603 structural fires and 385 acres of land burned. Assuming 5 tons of wood burned per structural fire (an engineering judgment of PEDCo-Environmental), and applying an emission factor of 17 lb emitted per ton burned,[12] emissions from structural fires in the Las Vegas Valley were:

$$\begin{aligned} \text{Structural fire emissions} &= (603 \text{ fires})(5 \text{ tons/fire}) \\ &\quad (17 \text{ lb/ton})(\text{ton}/2000 \text{ lb}) \\ &= 25.6 \text{ tons} \end{aligned} \qquad (2)$$

Applying an emission factor of 136.5 lb emitted per acre burned[12] to the 385 acres burned in the Valley gives 26.3 tons emitted. Controlled burning and incineration were not done to any significant extent. Therefore, total emissions from burning in the Las Vegas Valley were 51.9 tons.

Projections - Emissions from burned acreage were projected at the same level as the current value since there is no accurate method for estimating wildfire potential. Emissions from structural fires were projected by population. These emissions are shown in Table 2.5.

Allocations - Emissions from acreage burned were allocated to non-populated grids, while structural fire emissions were apportioned by population.

Further explanation of projections and allocations by population is given in Section 3.

Table 2.5 EMISSIONS FROM BURNING IN LAS VEGAS

	1975	1980	1985
Structural fire emissions (tons/yr)	25.6	28.8	32.8
Burned acreage emissions (tons/yr)	26.4	26.4	26.4
Total emissions (tons/yr)	52.0	55.2	59.2

MOBILE SOURCES

In this section, methods have been outlined for determining total annual area source emissions for all mobile source categories (aircraft, railroad, highway, and off-highway) in the Las Vegas Valley.

Aircraft

Emissions due to aircraft operations were calculated in the following manner:

$$EA = (LTO)(ENG)(EF) \qquad (3)$$

where

EA = Annual emissions for a given aircraft type
LTO = Annual number of landing-takeoff cycles for that aircraft type
ENG = Number of engines on that aircraft type
EF = Emission factor, usually given in lb/engine-LTO

These emissions are then summed over all aircraft types in operation at a given airport to determine the annual emissions from that airport.

The effect of aircraft upon the air quality in the Las Vegas Valley is limited to the three airports of significant size: McCarran International, Nellis Air Force Base, and

North Las Vegas Airport. All aircraft operation data for each airport[17] and the corresponding emissions are shown in Table 2.6.

Projections - Projected emissions are based on LTO projections per aircraft type supplied for each airport.[31] The projected emissions are shown in Table 2.7.

Allocations - Aircraft emissions were allocated to the grids occupied by each individual airport.

Railroad

Emissions due to railroad activity in the Las Vegas Valley were calculated as follows:

$$EG = (TMG)(GMD)(DPY)(EF)(CF) \tag{4}$$

where

EG = Annual emissions in tons per year of a given grid

TMG = Number of miles of track in that grid

GMD = Fuel usage rate in gallons per mile per day; estimated to be 88 gal/mi/day based in information received from the Union Pacific Railroad Company[18] for Las Vegas

DPY = Days per year, 365

EF = Emission factor found in EPA publication AP-42;[12] 0.025 lb/gal.

CF = Conversion factor; 0.0005 tons/lb.

In grids where switchyard operations are significant, fuel usage was estimated to be 214 gallons per day, and emissions were calculated accordingly. Total Valley emissions are the sum of the individual grid emissions.

Projections - These emissions were projected based on rail activity growth rates also supplied by Union Pacific. These are shown in Table 2.8.

Allocations - Emissions were allocated to the grids as they were calculated following the procedure outlined above.

Table 2.6 AIRCRAFT EMISSIONS IN LAS VEGAS 1975

Airport	Aircraft Type	ENG	LTO	Total END-LTO	EF (lb/ENG-LTO)	EA (tons/year)
McCarran International	Jumbo jet	3	655			
		4	656	4,589	1.30	3.0
	Long range jet	4	12,826	51,304	1.21	31.1
	Medium range jet	2	11,516			
		3	7,864			
		4	9,643	85,196	0.41	17.5
	Air carrier turboprop	2	2,856			
		4	796	8,896	1.10	4.9
	Military jet	1	428	428	0.31	neg.
	Military piston	2	19			
		4	4	54	0.28	neg.
	Business jet	2	4,469	8,938	0.11	0.5
	General Aviation turboprop	2	45	90	0.20	neg.
	General Aviation piston	1	66,543			
		2	16,982			
		4	1,341	105,871	0.02	1.1
						58.1
Nellis AFB	Jumbo jet	4	13	52	1.30	neg.
	Helicopter	1	396	396	0.25	0.1
	Military transport	4	56	224	1.10	0.1
	Military jet	1	14,377			
		2	29,425	73,227	0.31	11.3
	Military piston	4	110	440	0.28	0.1
						11.6
North Las Vegas	Business jet	1	2,850	2,850	0.11	0.2
	General Aviation piston	1	152,520			
		2	8,080	168,680	0.02	1.6
	Helicopter	1	4,750	4,750	0.11	0.3
						2.1
Total Study Area						71.8

Table 2.7 PROJECTED AIRCRAFT EMISSIONS IN LAS VEGAS

Airport	1975	1980	1985
McCarran International			
growth factor	-	1.133	1.283
emissions	58.1	65.8	74.5
Nellis Air Force Base			
growth factor	-	0.847	0.847
emissions	11.6	9.8	9.8
North Las Vegas Airport			
growth factor	-	1.164	1.355
emissions	2.1	2.4	2.8
Total Aircraft Emissions	71.8	78.0	87.1

Table 2.8 EMISSIONS DUE TO RAILROAD ACTIVITY IN LAS VEGAS

	1975	1980	1985
Growth factor	-	1.25	1.44
Emissions, tons/yr	13.5	16.4	19.4

Highway Vehicles

1975 daily VMT data was supplied by the State of Nevada Department of Highways, Las Vegas District Office.[19] The data was presented for grids aligned to the state plane coordinate system and transferred to the UTM coordinate grid system used in this study. An emission factor of 0.594 grams per mile was applied to the total VMT to obtain annual emissions in tons per year. This is a weighted emission factor based on standard emission factors[12] and percentages of VMT traveled by each vehicle type as shown below. The percentages of travel by vehicle type are estimates of PEDCo-Environmental based on information obtained from the Nevada Department of Highways.[20]

Light-duty gasoline-powered vehicles contribute
0.54 grams/mile over 94 percent of VMT = 0.508 g/mi

Heavy-duty gasoline-powered vehicles contribute
1.21 grams/mile over 4 percent of VMT = 0.048 g/mi

Heavy-duty diesel-powered vehicles contribute
1.90 grams/mile over 2 percent of VMT = 0.038 g/mi

Total weighted emission factor = 0.594 g/mi (5)

Total area emissions are the sum of the emissions by grid as calculated in equation 6. For example:

1975 annual emissions
in grid 70 (tons/year) = 12,867 VMT/day times
365 days/year times
0.594 grams/mile times
0.0022 lbs/gram times
0.0005 tons/lb
= 3.1 tons/year (6)

Projections - Due to the expected continued usage of unleaded fuel, highway vehicle particulate emission factors are expected to drop off in future years. The emission factors for light-duty gasoline-powered vehicles for 1980 and 1985 will be 0.36 grams/mile and 0.27 grams/mile, respectively. These are weighted factors based on the percent of travel by vehicles using leaded and unleaded fuels and their respective average emission factors found in Supplement 5.[32] The emission factors for both gasoline and diesel powered heavy-duty vehicles will remain the same for future years. Overall emission factors were calculated for the future years in the same manner as that for 1975 in equation 5. The emission factors for 1980 and 1985 are 0.425 grams/mile and 0.340 grams/mile, respectively.

1985 VMT by grid were supplied by the Department of Highways.[19] 1980 VMT were estimated by using a straight-line interpolation of the daily VMT per grid between 1975 and 1985.

The total projected emissions are shown in Table 2.9.

Allocations - Emissions for each year by grid were calculated using the VMT in each grid. Total area emissions are the sum of the emissions by grid.

Table 2.9 HIGHWAY VEHICLE EMISSIONS IN THE LAS VEGAS VALLEY

	1975	1980	1985
Emission factor, grams/mile	0.594	0.425	0.340
Annual emissions, tons/year	795.7	945.7	1,064.1

Off-Highway

Off-highway emissions in the Las Vegas Valley were calculated following the method outlined in EPA publication APTD-1135.[2] Gasoline usage is estimated to be 13 gallons per capita, mainly from the operation of 2 and 4-stroke lawnmowers and garden tractors. Gasoline usage by farm tractors and heavy-duty gasoline-powered equipment was negligible due to the mimimal number of vehicles of this type. Therefore, emissions from off-highway gasoline usage is calculated as follows:

Annual off-highway gasoline
emissions (tons/year) = 358,649 population times
13 gallons per capita times
42.9 lb/1000 gal. times
0.0005 tons/lb
= 99.6 tons/year (7)

Diesel usage is estimated to be 7.4 gallons per capita and 5,000 gallons per non-building construction employee.[21] Diesel usage by farm tractors is negligible. Therefore, emissions from off-highway diesel usage, mainly by heavy-duty construction equipment and heavy-duty general utility engines, is calculated as follows:

Annual diesel usage
(gallons) = 358,649 population times
7.4 gallons per capita
plus
1,114 non-building construction employees times
5,000 gallons per non-building construction employees
= 8,224,000 gallons per year (8)

Annual off-highway diesel emissions (tons/year)
= 8,224,000 gallons per year times
26.1 lb/1000 gallons times
0.0005 tons/lb
= 107.2 tons/year (9)

Total gasoline and diesel off-highway emissions
(tons/year) = 206.8 tons/year

Projections - Emissions were projected based on the increase in population and the increase in the number of non-building construction employees proportional to the population. These parameters and corresponding emissions are shown in Table 2.10.

Table 2.10 OFF-HIGHWAY GASOLINE AND DIESEL EMISSIONS IN THE LAS VEGAS VALLEY

	1975	1980	1985
Population	358,649	408,842	471,000
Non-building construction employees	1,114	1,273	1,470
Gasoline emissions	99.6	113.8	131.4
Diesel emissions	107.2	122.5	141.4
Total emissions (tons/year)	206.8	236.3	272.8

Allocations - Emissions for each year were allocated to grids by population.

Further explanation of projections and allocations by population is given in Section 3.

FUGITIVE DUST

In this section, methods are outlined for calculating emissions from all sources of fugitive dust in the Las Vegas Valley.

Construction

A list of topsoil disturbance permits for Clark County was supplied by the Clark County District Health Department.[22] Information obtained from this list included the acreage of each project and the number of months the project was active during 1975. For many of these projects the number of acres and the number of active months were adjusted to give a better representation of the actual construction activity. It was assumed that most of the projects were constructed on a fraction of the total acreage available, and that surface disturbance occurred only during a portion of the time allowed by the permit. Emissions for each permit were then calculated according to equation (10) and summed to obtain total construction emissions in the Las Vegas Valley.

$$E = (A)(M)(EF) \tag{10}$$

where

E = emissions in tons per year due to the construction activity for a given permit

A = estimated acreage used for actual construction

M = estimated months of active construction

EF = emission factor, 0.5 ton/acre-month

The emission factor of 1.0 ton/acre-month[23] was reduced by 50 percent to account for construction site watering.

Also, 433 acre-months of highway construction were estimated to be done in Las Vegas in 1975.[22,24,25,26] Total emissions are shown in Table 2.11.

Projections - Emissions due to construction in the Las Vegas Valley were projected by population. These are shown in Table 2.12.

Allocations - Construction emissions were allocated to grids by the change in the population. That is, the emissions in each grid for 1975 were obtained by multiplying total construction emissions by the ratio of the change in the grid population from 1975 to 1980 to the change in the Valley population from 1975 to 1980. Similar calculations were made for 1980 and 1985 emissions. Highway construction and population growth were observed to follow the same geographical patterns thereby justifying the allocation of highway construction by change in population.[27]

Table 2.11. CONSTRUCTION EMISSIONS IN LAS VEGAS 1975

Category	Tons/year
Residential	210
Commercial/Institutional	166
Industrial	19
Highway	225
Total	620

Table 2.12. EMISSIONS DUE TO CONSTRUCTION IN LAS VEGAS

	1975	1980	1985
Growth factor	-	1.139	1.284
Emissions, tons/year	620	706	796

Normal Paved Streets

Fugitive dust emissions from normal paved streets are proportional to the VMT on all streets classified as "normal" in the study area. The VMT used in this section were determined from those used in the section on Highway Vehicles. The VMT used in the Highway Vehicle section are totals of the VMT on both paved and unpaved roads. The VMT on paved roads includes that on both "normal" and "dirty" streets. Care was taken to use only those VMT on normal paved streets for calculations in this section.

As in the section on highway vehicles emissions were calculated by grid, and the total emissions were the sum of all grid emissions. An emission factor of 1.75 grams/mile[23] (corrected for 33 days of precipitation) was applied to the annual VMT in each grid to obtain the emissions from each grid. The adjusted emission factor is 1.59 grams/mile.

Projections - 1985 emissions were based on 1985 VMT projections in each grid by the Department of Highways.[19] 1980 emissions were estimated by using a straight-line interpolation of the daily VMT between 1975 and 1985. Total emissions for these study years are shown in Table 2.13.

Allocations - Emissions were allocated to each grid as they were calculated for each grid. Total emissions are the sum of the grid emissions for each year.

Table 2.13 FUGITIVE DUST EMISSIONS FROM NORMAL PAVED STREETS IN THE LAS VEGAS VALLEY

	1975	1980	1985
Emission factor, gram/mile	1.59	1.59	1.59
Emissions, ton/year	2,112.7	3,477.6	4,929.2

Dirty Paved Streets

Dirty paved streets were identified during the micro-inventory survey of the area. Streets so identified were Paradise Road between East Sahara Avenue and Desert Inn Road, Karen Avenue, one block east of Paradise Road, and Tropicana Avenue between Koval Lane and Bates Street. The approximate length of street, the average daily traffic,[20] and the annual emissions are shown in Table 2.14.

The emission factor for dirty paved streets is 28 gm/VMT on days with no precipitation.[23] Correcting for 33 days of precipitation, the annual average emission factor is 25.5 gm/VMT.

Projections - In a subsequent visit to these areas, Paradise Road and Karen Avenue were observed to be "normal," and the cause of the dirty condition on Tropicana Avenue was due to nearby construction. Therefore, these streets were classified as "dirty" only for the base year (1975), and reclassified as "normal" paved streets for the projection years.

Allocations - Emissions were allocated to the grids shown in Table 2.14.

Table 2.14 DIRTY PAVED STREET EMISSIONS IN LAS VEGAS

Grid	Street	Length, miles	ADT	VMT, daily	Emissions, tons/yr
57	Tropicana Ave.	0.5	26,600	13,300	13.6
68	Paradise Rd.	0.2	28,900	5,780	5.9
80	Karen Ave.	0.25	4,640	1,160	1.2
80	Paradise Rd.	0.75	30,233	22,675	23.2

Unpaved Roads

Unpaved roads were identified in the urban area by a general survey via automobile during the microinventory[23] of each hi-vol site. In the more rural parts of the study area, unpaved roads were identified from highway maps prepared by the State Department of Highways.

For unpaved roads identified in the microinventories, VMT were calculated from estimated average daily traffic and road lengths measured from estimated average daily traffic and road lengths measured from U.S.G.S. maps. For unpaved roads identified from highway maps, VMT were calculated by assuming a typical ADT of 25 vehicles per day. Care was taken not to include the same unpaved roads identified in the microinventory with the unpaved roads measured from the highway maps. It is recognized that the highway maps used are somewhat dated; however, these maps are the most current available which show road surface type. Also, meetings with the Department of Highways of both Clark County and the State of Nevada revealed that there is no information available which is more current.

An emission factor of 5.3 lb/VMT was calculated based on soil type (gravel assumed), precipitation (33 days), and average vehicle speed (30 mph).[23] This value was adjusted according to the average vehicle speed on each unpaved road. Total emissions in the study area amounted to 5,818 tons/year.

Projections - Emissions from unpaved roads were assumed to remain the same for 1980 and 1985. As traffic on an unpaved road increases, the road is often times paved. It is assumed in the projections that VMT on unpaved roads eliminated by paving programs would be approximately off-set by increases in VMT on new and existing unpaved roads in the Valley.

Allocations - The emissions were allocated to the grids in which the unpaved roads are located.

Sand and Gravel Pits

Sand and gravel operations were identified during the microinventory surveys[23] around the hi-vol sites and by a general area-wide survey. These operations were located on U.S.G.S. maps in order to determine the area involved more accurately. The sand and gravel pits were identified as active or inactive, having emission factors of 3.4 tons/acre/year and 1.14 tons/acre/year, respectively.[23] Total emissions due to sand and gravel operations in Las Vegas in 1975 were 711 tons.

Projections - Sand and gravel operations were expected to remain fairly constant over the next ten years. Therefore, emissions were projected at the same level for 1980 and 1985.

Allocations - Emissions were allocated to grids where sand and gravel operations were identified.

Agriculture

Agricultural fields were identified during the microinventories. Additional information regarding total acreage and crop types were obtained from the Clark County agricultural agent.[28]

Emissions from agricultural fields are twofold: those from tilling operations and those from windblown dust. The emission factor for tilling is 16.6 s lb/acre/tilling operation,[23] where s is the silt content of the soil. Since very little farming is done in the Las Vegas Valley, and most crops are only forage, tilling operations are assumed to be done only once each year. Assuming the silt content of the soil to be 59 percent[28] in most of the farmed areas in Las Vegas, the emission factor becomes approximately 980 lb/acre/year, or 0.490 tons/acre/year.

The emission factor for windblown dust is dependent on a variety of parameters including soil erodibility, surface roughness, climatic data, and vegetative cover.[23] After determining these parameters, the emission factor was calculated to be 0.112 tons/acre/year in most of the agricultural areas.

Applying these emission factors to the 300 acres of agricultural land in the Las Vegas Valley, total emissions amount to 180 tons/year.

Projections - Agricultural operations are not expected to increase in the Las Vegas Valley to any significant degree. Therefore, emissions were projected at the same level.

Allocations - Emissions were allocated to grids according to the location of the agricultural acreage.

Various Fugitive Dust Sources

The fugitive dust sources included in this category are:

Cleared areas,
Playgrounds,
Unpaved parking lots,
Railroad right-of-ways and yards,
Heavy equipment storage,
Road shoulders, and
Horse corrals.

These sources were identified in the microinventories around the hi-vol sites and by a general area-wide survey. They were located on the appropriate U.S.G.S. map and labeled with pertinent data, such as size and boundaries, observed activity, and any other important parameters. Emission factors were obtained from the Task B Report[23] and applied to estimate annual emissions. The 1975 emissions were allocated to the grids in which they were identified and projected as constant for 1980 and 1985. Emissions for the various fugitive dust categories by grid in 1975 are given in Appendix B. Emissions from all categories except cleared areas will remain constant for 1980 and 1985. Variations in cleared are emissions are shown in Appendix C.

Cleared Areas - The emission factors for cleared areas account for soil type, vegetation, and traffic. The factors are as follows:

	Emission factor, ton/acre/yr			
	Vegetation			
Soil type	None	Sparse	Moderate	Heavy
Rocky or demolition waste	0.78	0.64	0.51	0.18
Sandy	1.28	1.09	0.90	0.42
Fine	2.29	2.06	1.77	0.96
Clay loam	1.01	0.85	0.69	0.29

For occasional traffic (1 veh/day) multiply the value by 1.05, and for regular traffic (5 veh/day) multiply the value by 1.20. The total 1975 emissions from this category are 2310 ton/yr.

The Clark County District Health Department expects 40 percent of the cleared area within a centrally located 20 grid region (grids 57, 58, 59, 60, 67, 68, 69, 70, 79, 80, 81, 82, 91, 92, 93, 94, 101, 102, 103, and 104) to be developed by 1985. Therefore, the emissions from cleared areas in these grids will be reduced in 1980 and 1985. The total emissions from this category are 2,108 and 1,906 ton/year for 1980 and 1985, respectively. Of all fugitive dust sources described in this section, only emissions from cleared areas will vary from year to year. These emissions are shown by grid in Appendix C.

Playgrounds - Emissions were calculated for playgrounds only where their proximity to the hi-vol location would influence readings. The emission factor for this category is 2.5 ton/acre/yr and the total annual emissions are 5 ton/yr.

Unpaved Parking Lots - Emission factors were developed for either vehicle usage or surface area of unpaved parking lots. Where VMT on an unpaved parking lot could be estimated (from average number of vehicles and average distance driven), emissions were calculated from the VMT. Where VMT on a lot could not be estimated, dimensions of the lot were used to estimate emissions. The emission factors for this category are 1.8 lb/VMT when traffic estimates could be made, and 0.17 ton/yr per 10,000 sq ft when only the area could be determined. The total annual emissions from unpaved parking lots is 38 ton/yr.

Railroad Right-of-Ways and Yards - This category was identified by both the microinventory and the U.S.G.S. maps. Lengths were taken from U.S.G.S. maps for rail lines. Widths of single track lines were estimated at 12 ft and double track lines at 24 ft. The area of rail yards were estimated from U.S.G.S. maps. The emission factor for this category is 0.9 ton/acre/yr and the estimated total annual emissions are 203 ton/yr.

Heavy Equipment Storage - Sources in this category were also identified in the microinventory. The emission factor is 1.28 ton/acre/yr and the estimated annual emissions from heavy equipment storage yards are 28 ton/yr.

Road Shoulders - Upon conversations with State, county, and local highway departments, it was determined that data are not available that would enable the identification of unpaved road shoulders in the study area. Therefore, only road shoulders with regular traffic were identified in the microinventories. Since dusty road shoulders which have traffic also are used for parking (and the emission factors for road shoulders and unpaved parking lots are the same, 1.8 lb/VMT), road shoulders with traffic were included in the unpaved parking category. In addition, cleared areas adjacent to roadways were noted as such and not as road shoulders. As a result, the wind-blown emissions from road shoulders could not be estimated.

Horse Corrals - Horse corrals were identified during the microinventories. An emission factor of 3 ton/acre/yr was used to estimate total annual emissions of 51 ton/yr.

3. PROJECTIONS AND ALLOCATIONS BY POPULATION

In this section, the methods for projecting and allocating emissions by population and the justifications for doing so are outlined.

Projections of area-wide emissions by population are obtained by multiplying the base year (1975) emissions by the ratios of the populations of the projection year to the base year. These ratios may also be referred to as growth factors. For the Las Vegas Valley, the population growth factors are calculated as follows:

$$\text{1980 growth factor} = \frac{\text{1980 Valley population}}{\text{1975 Valley population}}$$

$$= \frac{408{,}842}{358{,}649} = 1.140$$

$$\text{1985 growth factor} = \frac{\text{1985 Valley population}}{\text{1975 Valley population}}$$

$$= \frac{471{,}000}{358{,}649} = 1.313$$

These factors are multiplied by the 1975 Valley emissions to obtain the 1980 and 1985 Valley emissions, respectively, for each category projected by population.

Allocations to grids of area-wide emissions by population are obtained by multiplying the area-wide emissions for a given year by the ratios of the populations of each grid to the area-wide population for that year. These ratios, which are essentially the percentages of the total area-wide emissions contributed by each grid, may also be referred to as allocation or apportioning factors. For the

Las Vegas Valley, the population apportioning factors are calculated as follows:

$$\text{1975 grid 1 apportioning factor} = \frac{\text{1975 grid 1 population}}{\text{1975 Valley population}}$$

$$\text{1975 grid 2 apportioning factor} = \frac{\text{1975 grid 2 population}}{\text{1975 Valley population}}$$

and so on for all grids in the Valley study area. Apportioning factors for projection years are calculated in a similar manner:

$$\text{1980 grid 1 apportioning factor} = \frac{\text{1980 grid 1 population}}{\text{1980 Valley population}}$$

$$\text{1985 grid 1 apportioning factor} = \frac{\text{1985 grid 1 population}}{\text{1985 Valley population}}$$

These apportioning factors are multiplied by the area-wide emissions in order to obtain the emissions from each grid in each year, respectively.

Grid populations for the base year (1975) were based on population figures by traffic zones in the Las Vegas Valley. This information was provided by the Clark County Regional Planning Council in Las Vegas. Grid populations for the projections years were estimates of PEDCo-Environmental based on discussions with the Clark County Regional Planning Council about population growth patterns (the limitations and potential for growth) in specific areas of the Las Vegas Valley. These discussions were used as an aid in modifying projected population distribution maps[29] so that population estimates could be made for 1980 and 1985.

Emissions from the following categories were projected and allocated by population:

- residential and commercial/institutional fuel combustion,
- structural fires,

Las Vegas Valley, the population apportioning factors are calculated as follows:

$$\text{1975 grid 1 apportioning factor} = \frac{\text{1975 grid 1 population}}{\text{1975 Valley population}}$$

$$\text{1975 grid 2 apportioning factor} = \frac{\text{1975 grid 2 population}}{\text{1975 Valley population}}$$

and so on for all grids in the Valley study area. Apportioning factors for projection years are calculated in a similar manner:

$$\text{1980 grid 1 apportioning factor} = \frac{\text{1980 grid 1 population}}{\text{1980 Valley population}}$$

$$\text{1985 grid 1 apportioning factor} = \frac{\text{1985 grid 1 population}}{\text{1985 Valley population}}$$

These apportioning factors are multiplied by the area-wide emissions in order to obtain the emissions from each grid in each year, respectively.

Grid populations for the base year (1975) were based on population figures by traffic zones in the Las Vegas Valley. This information was provided by the Clark County Regional Planning Council in Las Vegas. Grid populations for the projections years were estimates of PEDCo-Environmental based on discussions with the Clark County Regional Planning Council about population growth patterns (the limitations and potential for growth) in specific areas of the Las Vegas Valley. These discussions were used as an aid in modifying projected population distribution maps[29] so that population estimates could be made for 1980 and 1985.

Emissions from the following categories were projected and allocated by population:

- residential and commercial/institutional fuel combustion,
- structural fires,

- off-highway gasoline and diesel fuel combustion,
- construction.

Emissions from residential fuel combustion are obviously proportional to the population or to the number of dwelling units occupied by the population. Commercial/institutional establishments are assumed to be located predominantly in or near population centers. This was verified by a land use map provided by the Clark County Regional Planning Council.[30] Also, the number of these establishments is assumed to be directly related to the population. Therefore, emissions from commercial/institutional fuel combustion can be allocated and projected by population.

It is a logical assumption that the number of building units or structures in a given area is proportional to the population of the area. This is in agreement with the assumptions on fuel combustion. It also seems logical to assume that the number of structural fires is proportional to the population. The location of future fires cannot be determined to any significant degree of accuracy, therefore, structural fires are allocated and projected by population in general.

The majority of off-highway gasoline emissions are from lawnmowers and garden tractors used by the general population. Therefore, these emissions can validly be projected and apportioned by population.

Roadway construction is the source of two types of emissions: diesel fuel combustion and fugitive dust. Roadway construction and population growth were observed to follow the same geographical patterns.[27] Therefore, off-highway diesel fuel combustion emissions and fugitive dust emissions from roadway construction (and also building construction) can be projected by population and apportioned by the change in population in each grid.

4. PARTICLE SIZING AND SEASONAL DISTRIBUTION

In this section are presented tables which show the seasonal variation of particulate emissions and the particle size distribution of the annual emissions from fugitive dust sources in the Las Vegas Valley. Seasonal variations are shown in Table 4.1 for each quarter of the calendar year. The seasonal adjustment factors are from Table 5.3 of the Task B Report.[23]

The particle size distribution is shown in Table 4.2 for two particle size ranges: less than three microns, and between three and thirty microns. The particle size adjustment factors are from Table 5.1 of the Task B Report.[23]

Table 4.1. LAS VEGAS SEASONAL EMISSIONS BY SOURCE CATEGORY, TONS

Fugitive Dust Sources	1975				1980				1985			
	Wnt.	Spg.	Sum.	Fall	Wnt.	Spr.	Sum.	Fall	Wnt.	Spg.	Sum.	Fall
Construction	155.0	155.0	155.0	155.0	176.5	176.5	176.5	176.5	199.0	199.0	199.0	199.0
Normal streets	534.5	534.4	534.5	534.5	878.4	878.4	878.5	878.4	1232.4	1232.4	1232.5	1232.4
Dirty streets	10.9	10.9	10.9	10.9								
Unpaved roads	1454.5	1454.5	1454.5	1454.5	1454.5	1454.5	1454.5	1454.5	1454.5	1454.5	1454.5	1454.5
Sand and gravel pits	177.7	177.7	177.8	177.8	177.7	177.7	177.8	177.8	177.7	177.7	177.8	177.8
Agriculture	45.0	67.5	40.5	27.0	45.0	67.5	40.5	27.0	45.0	67.5	40.5	27.0
Various fugitive sources:												
Cleared areas	577.5	866.2	519.7	346.5	527.1	790.6	474.3	316.2	476.6	714.9	428.9	286.1
Heavy equipment storage	6.9	10.4	6.2	4.1	6.9	10.4	6.2	4.1	6.9	10.4	6.2	4.1
Playgrounds	1.2	1.9	1.1	0.8	1.2	1.9	1.1	0.8	1.2	1.9	1.1	0.8
Unpaved parking lots	9.6	9.6	9.7	9.6	9.6	9.6	9.7	9.6	9.6	9.6	9.7	9.6
Road shoulders*												
Railroad right-of-ways	50.7	76.1	45.7	30.4	50.7	76.1	45.7	30.4	50.7	76.1	45.7	30.4
Fugitive dust totals	3023.5	3364.2	2955.7	2751.2	3327.6	3643.2	3264.9	3075.4	3653.6	3944.0	3595.9	3421.7

* Road shoulder emissions included with unpaved parking lot emissions.

Table 4.2 LAS VEGAS PARTICLE SIZE EMISSIONS BY SOURCE CATEGORY, TONS/YEAR

	1975		1980		1985	
Fugitive dust sources	<3μ	3-30μ	<3μ	3-30μ	<3μ	3-30μ
Construction	372.8	347.2	310.7	395.3	350.3	445.7
Normal streets	1111.7	1026.2	1827.1	1686.6	2563.4	2366.3
Dirty streets	22.7	20.9				
Unpaved roads	3025.4	2792.6	3025.4	2792.6	3025.4	2792.6
Sand and gravel pits	405.3	305.7	405.3	305.7	405.3	305.7
Agriculture	88.2	91.8	88.2	91.8	88.2	91.8
Various fugitive sources:						
Cleared areas	1570.7	739.2	1433.5	674.7	1296.4	610.1
Heavy equipment storage	18.8	8.8	18.8	8.8	18.8	8.8
Playgrounds	3.4	1.6	3.4	1.6	3.4	1.6
Unpaved parking lots	20.0	18.5	20.0	18.5	20.0	18.5
Road shoulders*						
Railroad right-of-ways	138.0	64.9	138.0	64.9	138.0	64.9
Fugitive dust totals	6677.0	5417.4	7270.4	6040.5	7909.2	6706.0

* Road shoulder emissions included with unpaved parking lot emissions.

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3. Local Climatological Data. Annual Summary with Comparative Data, Las Vegas, Nevada. U.S. Department of Commerce, National Oceanic and Atmospheric Administration Environmental Data Service, 1974.

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6. APPENDICES

APPENDIX A. POINT SOURCES IN LAS VEGAS VALLEY STUDY AREA

Grid	Plant Name	UTM		TSP, T/yr.		
		E, km	N, km	1975	1980	1985
27	WMK Transit Mix, Gibson	677.4	3992.0	127	140	155
27	Industrial Asphalt	677.5	3991.9	8	9	10
28	Stauffer Chemicals	679.5	3990.2	27	30	33
29	Flintkote	680.1	3990.4	49	54	60
29	Kerr McGee	680.3	3990.2	33	36	40
29	Titanium Metals	680.8	3990.3	181	200	221
40	Las Vegas Bldg. Materials	678.6	3994.0	231	255	282
40	Bentonite Co.	678.8	3992.4	20	22	24
40	Nevada Rock and Sand	678.8	3992.7	160	177	195
48	Nevada Power, Clark	675.8	3995.2	130	144	158
52	Chas. Brown Construction	656.6	3998.0	50	55	61
52	Stocks Mill and Supply	656.6	3992.1	145	159	176
52	WMK Transit, Buffalo	656.6	3997.3	256	282	312
52	Arrow Ready Mix	656.8	3996.2	76	84	93
52	Wells Cargo	657.8	3999.2	415	458	506
66	Stocks Mill and Supply	663.4	3998.4	6	7	7
85	Nevada Power, Sunrise	676.9	4000.9	144	159	176
86	Nevada Ready Mix	677.7	4000.9	21	23	26
85	Stewart Brothers	677.8	4000.9	681	752	830
85	Whitting Brothers	677.1	4000.8	25	28	30
86	Diamond Construction	678.2	4001.2	130	144	158
91	WMK Transit Mix, Industrial Rd.	665.4	4002.2	7	8	9
97	Southern Nevada Paving	676.7	4003.2	32	35	39
102	Las Vegas Building Mat., W. Bonanza	666.5	4004.9	5	6	6
145	Nevada Recycle Corp.	673.6	4015.3	9	10	11
146	Cheyenne Construction	678.4	4015.2	18	20	22
Total				2986	3297	3640

APPENDIX B. VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-1985 (tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
1							
2			3.0				3.0
3			2.5				2.5
4							
5							
6							
7							
8			4.1				4.1
9			3.8				3.8
10			16.3				16.3
11			1.2				1.2
12							
13							
14		1.3	5.9				26.4
15	5.0	0.4	5.2				66.9
16			0.6				0.6
17							
18							
19			1.8				1.8
20							
21							
22							
23			0.8				0.8
24			1.5				1.5
25			1.5				1.5
26			0.8				0.8
27							
28		0.7	1.1				1.8
29							
30							
31			0.9				0.9
32			2.1				2.1
33			1.8				5.3
34			1.5				1.5
35			0.9				0.9
36							
37							
38							
39							
40		2.0		10.7			31.9
41							
42			1.7				1.7
43		0.6					73.1
44							

APPENDIX B (continued). VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-1985 (tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
45							
46							149.0
47							
48							
49							
50		9.6					9.6
51							
52							161.0
53							
54							
55							41.0
56			1.7				20.7
57		0.2					37.8
58							
59							171.0
60							171.0
61							
62						39.0	144.9
63							
64							
65							
66			0.8				0.8
67			0.8				11.5
68		0.1					22.9
69							
70							52.2
71							59.0
72							
73							
74							
75							
76							62.7
77							
78							66.9
79		10.9	3.0	7.1			73.5
80							70.9
81							
82							30.9
83							
84							
85		0.4					7.8
86							
87							
88							

APPENDIX B (continued). VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-1985 (tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
89							
90							96.6
91		4.7	6.1				153.8
92		1.5	86.7				88.2
93							48.3
94		3.0					44.4
95							11.5
96							27.5
97							
98							
99							
100							5.5
101			1.0	5.0			100.6
102		0.9	34.4	4.8			43.3
103						12.0	54.1
104							16.3
105							
106							52.7
107							
108							
109							
110							120.0
111							
112							
113							
114							
115							
116			1.5				8.1
117		2.1					75.1
118							
119							
120							
121							
122							
123							
124							
125							45.1
126							
127			1.2				1.2
128							
129							
130							
131							
132							

APPENDIX B (continued). VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-1985 (tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
133							
134							
135							
136			1.8				1.8
137			3.2				3.2
138		0.1					20.4
139							
140							
141							
142							
143							
144							
145			2.3				2.3
146			4.4				4.4
147			1.0				1.0
148							
Total	5.0	38.5	208.9	27.6	0[a]	51.0	2640.9

[a] Emissions included with unpaved parking lots.

APPENDIX C. LAS VEGAS CLEARED AREA EMISSIONS

(tons/yr)

Grid	1975	1980	1985
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14	19.2	19.2	19.2
15	56.3	56.3	56.3
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33	3.5	3.5	3.5
34			
35			
36			
37			
38			
39			
40	19.2	19.2	19.2
41			

APPENDIX C (continued). LAS VEGAS CLEARED AREA EMISSIONS

(tons/yr)

Grid	1975	1980	1985
82	30.9	24.7	18.5
83			
84			
85	7.4	7.4	7.4
86			
87			
88			
89			
90	96.6	96.6	96.6
91	143.0	114.4	85.8
92			
93	48.3	38.6	29.0
94	41.4	33.1	24.8
95	11.5	11.5	11.5
96	27.5	27.5	27.5
97			
98			
99			
100	5.5	5.5	5.5
101	94.6	75.7	56.8
102	3.2	2.6	1.9
103	42.1	33.7	25.3
104	16.3	13.0	9.8
105			
106	52.7	52.7	52.7
107			
108			
109			
110	120.0	120.0	120.0
111			
112			
113			
114			
115			
116	6.6	6.6	6.6
117	73.0	73.0	73.0
118			
119			
120			
121			
122			

APPENDIX C (continued). LAS VEGAS CLEARED AREA EMISSIONS

(tons/yr)

Grid	1975	1980	1985
42			
43	72.5	72.5	72.5
44			
45			
46	149.0	149.0	149.0
47			
48			
49			
50			
51			
52	161.0	161.0	161.0
53			
54			
55	41.0	41.0	41.0
56	19.0	19.0	19.0
57	37.6	30.1	22.6
58			
59	171.0	136.8	102.6
60	171.0	136.8	102.6
61			
62	105.9	105.9	105.9
63			
64			
65			
66			
67	10.7	8.6	6.4
68	22.8	18.2	13.7
69			
70	52.2	41.8	31.3
71	59.0	59.0	59.0
72			
73			
74			
75			
76	62.7	62.7	62.7
77			
78	66.9	66.9	66.9
79	52.5	42.0	31.5
80	70.9	56.7	42.5
81			

APPENDIX C (continued). LAS VEGAS CLEARED AREA EMISSIONS

(tons/yr)

Grid	1975	1980	1985
123			
124			
125	45.1	45.1	45.1
126			
127			
128			
129			
130			
131			
132			
133			
134			
135			
136			
137			
138	20.3	20.3	20.3
139			
140			
141			
142			
143			
144			
145			
146			
147			
148			
Total	2,309.9	2,108.2	1,906.5

PART 2. PARTICULATE EMISSIONS INVENTORY FOR RENO, NEVADA

1. SUMMARY

The purpose of this project was to prepare an inventory of all point and area sources of particulate emissions in a study area centered around Reno, Nevada for the period 1975 to 1985.

The area source categories included in this inventory are shown in Table 1.1. The list of categories is conventional except for several fugitive dust categories which have been included. The category of "Industrial Processes" has also been included to account for point sources. Individual point source listings are presented in Appendix A.

Particulate emissions are summarized by category for the base year (1975), and two projection years (1980 and 1985) in Table 1.1. Survey data, emission estimating procedures, and projection techniques that were used to obtain these values are documented in detail in Section 2 of this report for each source category.

In order to input area source emissions into an atmospheric dispersion model, the distribution of these emissions within the study area must be determined. This was accomplished by allocating the total emissions for each category into grid squares covering the entire study area, as shown in Figure 1.1. The grid system has a total of 61 grids made up of squares which are 2 km on a side within the urban region, and 6 km on a side in the more rural regions of the study area. The grid network is aligned to the state plane coordinate system, consistent with the grid system used by the State of Nevada Department of Highways in the Reno area.

Table 1.1 RENO PARTICULATE EMISSION INVENTORY SUMMARY, TONS/YEAR

Source category	1975	1980	1985
Fuel combustion	388.2	428.3	480.4
Industrial processes	23.0	26.6	5.2
Burning	1099.5	1105.2	1112.5
Mobile Sources:			
Aircraft	10.7	13.3	16.7
Railroad	24.7	28.8	33.2
Auto exhaust	437.3	386.6	369.0
Off-highway	85.5	94.3	105.3
Fugitive Dust Sources:			
Construction	814.0	899.2	1008.0
Normal paved streets	1034.1	1277.9	1522.7
Dirty paved streets	20.6	20.6	20.6
Unpaved roads	3969.0	3969.0	3833.0
Sand and gravel pits	460.0	460.0	316.0
Agriculture	121.0	121.0	121.0
Street sanding	140.0	140.0	140.0
Various Fugitive Sources:			
Cleared areas	40.1	40.1	40.1
Heavy equipment storage	3.4	3.4	3.4
Playgrounds	50.9	50.9	50.9
Unpaved parking lots	38.8	38.8	38.8
Road shoulders	2.8	2.8	2.8
Railroad right-of-ways	35.6	35.6	35.6
Horse corrals	9.0	9.0	9.0
Total	8808.2	9151.4	9264.2

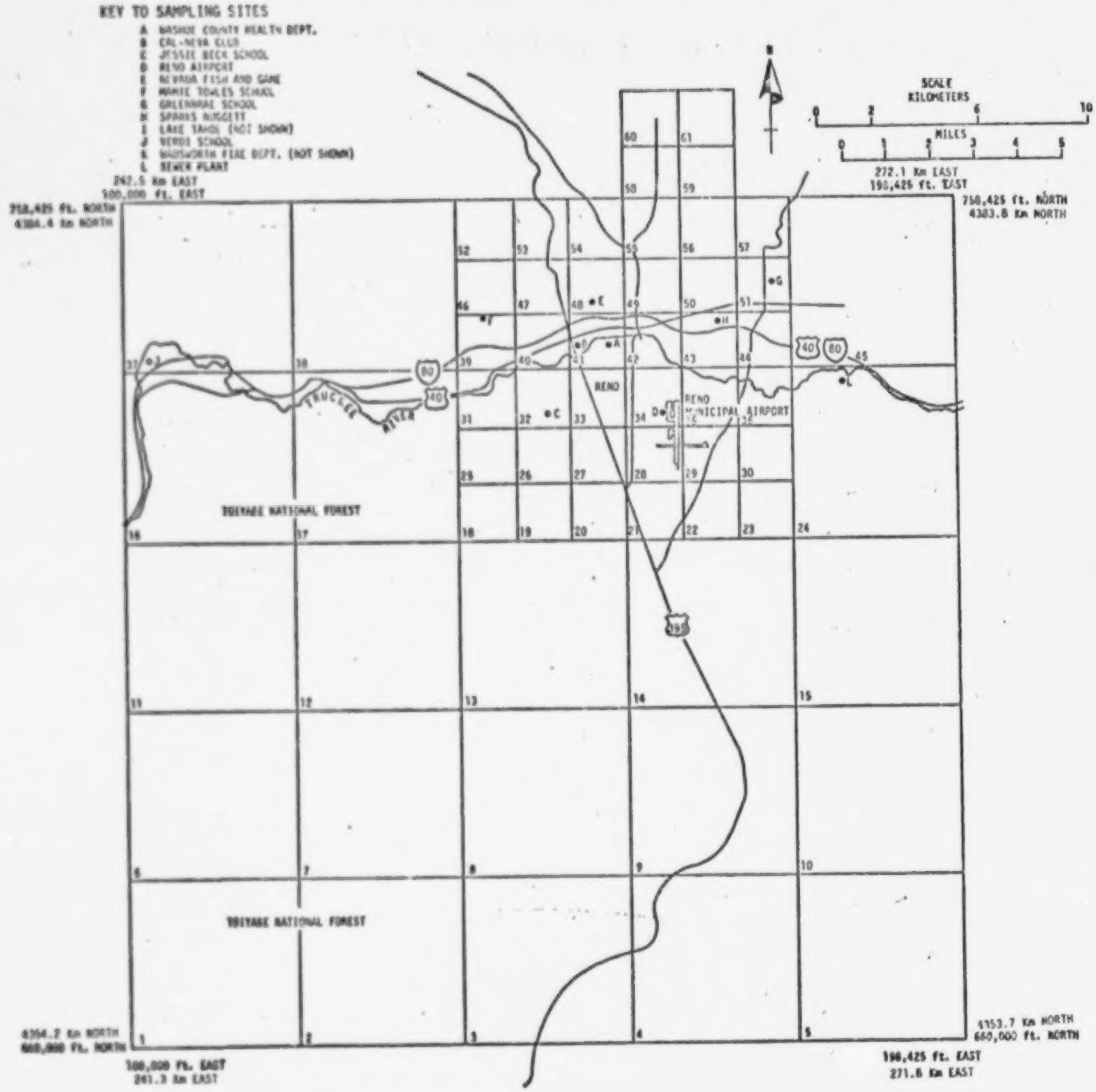

KEY TO SAMPLING SITES
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
262.5 Km EAST
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
N
SCALE
KILOMETERS
0
2
6
10
MILES
0
1
2
3
4
5
272.1 Km EAST
198,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
TRUCKEE RIVER
RENO
RENO MUNICIPAL AIRPORT
80
40
395
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
4354.2 Km NORTH
660,000 ft. NORTH
100,000 ft. EAST
261.3 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH
198,425 ft. EAST
271.6 Km EAST

Figure 1.1 Reno study area with grid overlay.

The Department of Highways grid was extended north of Sparks to include Sun Valley.

The procedures used to allocate emissions to the grids for each source category are also explained in Section 2. The resulting emissions by grid and by source category are presented in Tables 1.2, 1.3, and 1.4 for the years 1975, 1980, and 1985, respectively. Emissions by grid from each of the various fugitive dust source categories are presented in Appendix B.

In general, emissions are observed to increase over time. However, care should be taken when drawing conclusions from the totals appearing in the summary tables. The emissions from a few sources, such as those from unpaved roads, which represent a large percentage of the total area-wide emissions, may in fact, have very little impact on the air quality due to the even distribution of these sources throughout the area. Sources which represent a smaller percentage of the total emissions could have a larger impact on air quality, if they are concentrated in a smaller area.

The source strength, or emission density of each grid is determined by dividing the total emissions from all sources in that grid by the area of the grid. Emission densities for all grids in each study year are shown in Tables 1.2, 1.3, and 1.4. Ranges of these emission densities are graphically displayed in Figures 1.2, 1.3, and 1.4 for the years 1975, 1980, and 1985, respectively. Note that the grids having higher emission densities occur in and near the urbanized areas.

Hi-vol particulate samplers are located in many of the grids which have high emission densities. This shows that these samplers have been placed in areas where the highest particulate levels in the study area could be expected to be recorded.

Table 1.2. EMISSIONS SUMMARY BY GRID, RENO, 1975
(ton/yr)

Grid	Stationary			Mobile			Fugitive dust									
	Fuel comb.	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy. exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Str. sand	Var. fugit. sourc.	Total ton/yr	Emiss. dens., ton/ mi²/yr
1																
2																
3	0.6		124.8		10.7		0.7	25.4		162					324.2	23.3
4	0.6		124.8				0.7	0.1		205					331.2	23.8
5			62.4							65					127.4	9.2
6																
7										11					11.0	0.8
8	0.9		124.9		2.4		5.3	5.8		258					397.3	28.6
9	5.5		125.1		23.0	0.7	12.6	54.5		205					426.4	30.7
10	0.3		62.4		1.5			3.7		226	66				359.9	25.9
11																
12			2.0							108					110.0	7.9
13	4.3		125.3		0.2	1.0	10.1	0.5		129					270.4	19.5
14	9.8		125.9		25.0	1.9	81.7	59.1		86					389.4	28.0
15			62.4							162					224.4	16.1
16	1.6		2.2	5.9	13.7		5.8	32.3		86				3.4	150.9	10.9
17	6.8		2.4	4.9	12.8	0.6	10.4	30.3		258				2.6	328.8	23.7
18	1.3									43					44.3	28.7
19	0.9						5.8	0.8							7.5	4.9
20	3.4				0.9			2.2							6.5	4.2
21	5.6		1.1		9.7	1.7	48.6	23.0							89.7	58.1
22	1.2		6.9		1.7		11.6	4.1							25.5	16.5
23			7.0				22.0			22					51.0	33.0
24	4.2		62.6	1.3	0.2		3.6	0.4		194		26		0.6	292.9	21.1
25	3.4						5.8								9.2	6.0
26	6.1		1.3		1.9	2.1	22.8	4.4					1.0		39.6	25.6
27	11.4		1.9		16.3	2.9	16.3	38.6					8.5		95.9	62.1
28	16.1		1.1	4.7	7.6	1.8	21.1	18.0					4.0		74.4	48.2
29	2.3		7.0	2.4	2.5		22.0	5.8				53			95.0	61.5
30	0.2		7.0		0.7		22.0	1.6							31.5	20.4
31	12.7		2.0	1.0	2.6	3.2	9.4	6.2					1.4	0.6	39.1	25.3
32	18.4		3.4		13.8	5.3	16.2	32.6					7.2	16.2	113.1	73.3
33	40.5		5.6		36.3	8.8	24.3	85.9					18.8	2.6	222.8	144.3
34	13.0		1.2	2.4	12.1	1.9	11.2	28.6		9	13		6.3	13.7	112.4	72.8
35	0.6		0.1		2.3		16.2	5.5							24.7	16.0
36	0.7		7.0		1.6		16.2	3.7				39			68.2	44.2
37	0.4		2.1	1.7	0.9		9.4	2.1		179				5.1	200.7	14.4
38	0.1		2.0				5.8			323					330.9	23.8
39	25.9		3.9	0.4	9.5	6.1	16.4	22.5		9			4.9	12.5	111.1	72.0
40	23.1		3.7	1.4	34.2	5.8	12.0	81.0					17.8	1.4	180.4	116.8
41	17.5		4.0	1.5	67.9	6.3	10.2	160.6		6		1	35.2	3.1	313.3	202.9
42	4.3	19.0	1.1	1.4	34.3	1.8	10.5	81.3		163	131		17.9	5.5	471.1	305.1
43	6.5		0.8	2.7	16.3	1.2	16.0	37.3	20.6					22.2	123.6	80.1
44	2.1		0.1	1.2	6.0		27.1	14.2		170				5.3	226.0	146.4
45	6.7	4.0	2.0	1.3	6.4		5.8	15.3		75	250			2.1	368.6	26.5
46	15.9		0.5		0.8	0.6	9.1	1.8		108			0.4	3.2	140.3	90.9
47	18.6		2.4		9.3	3.7	16.7	22.1		2			4.9	0.1	79.8	51.7
48	8.1		2.5		9.7	4.0	14.4	22.9		60		2	5.0	49.1	177.7	115.1
49	9.8		2.5		12.9	4.0	12.2	30.5					6.7		78.6	50.9
50	27.1		4.8		13.0	7.5	31.0	30.8						1.4	115.6	74.9
51	23.3		1.2		3.3	1.8	40.5	7.7		28				10.5	116.3	75.3
52	0.2		0.1							22					22.3	14.4
53	1.1		1.5		3.0	2.3	2.1	7.1		22				0.3	39.4	25.5
54	1.1		0.3		0.8	0.5	4.0	1.8		22				0.1	30.6	19.8
55	1.6		0.2		4.2		2.8	9.9						12	30.7	19.9
56	4.8		0.9		2.8	1.4	59.4	6.7							76.0	49.2
57	11.8		1.2		1.5	1.8	28.9	3.6		22					70.8	45.9
58	1.2		0.5		0.2	0.8	17.1	0.4		86					106.2	68.8
59	0.5				0.2		5.8	0.4		57					63.9	41.4
60	2.7		0.5		0.4	0.8	17.0	0.7		229				7	258.1	167.2
61	1.4		0.5		0.2	0.8	17.0	0.3		157					177.2	114.8
Tot.	388.2	23.0	1099.5	35.4	437.3	85.5	814.0	1034.1	20.6	3969.0	460.0	121.0	140.0	180.6	8808.2	

Table 1.3. EMISSIONS SUMMARY BY GRID, RENO, 1980
(ton/yr)

	Stationary			Mobile			Fugitive dust									
Grid	Fuel comb.	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy. exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Str. sand	Var. fugit. sourc.	Total ton/yr	Emiss. dens., ton/ mi²/yr
1																
2																
3	0.6		132.8		8.8		0.8	29.2		162					334.2	24.0
4	0.6		132.8		0.3		0.8	1.0		205					340.5	24.5
5			66.4							65					131.4	9.5
6																
7										11					11.0	0.8
8	1.1		132.9		5.4		5.9	17.7		258					421.0	30.3
9	6.6		133.1		15.0	0.8	13.8	49.7		205					424.0	30.5
10	0.3		66.4		1.1			3.6		225	66				362.2	26.1
11																
12			2.0							108					110.0	7.9
13	4.8		133.4		4.0	1.1	11.2	13.3		129					296.8	21.4
14	14.0		89.8		17.8	2.8	90.2	58.9		86					359.5	25.9
15			66.4		0.3			1.0		162					229.7	16.5
16	1.9		2.2	6.8	12.7		6.5	42.1		86				3.4	161.6	11.6
17	7.6		2.4	5.7	12.3	0.7	11.5	40.7		258				2.6	341.5	24.6
18	1.3				0.3			0.9		43					45.5	29.5
19	0.9				0.7		6.4	2.4							10.4	6.7
20	3.4				2.9			9.8							16.1	10.4
21	6.9		1.2		9.4	2.2	53.8	31.0							104.5	67.7
22	1.2		7.4		1.8		12.7	5.9							29.0	18.8
23			7.5				24.3	0.1		22					53.9	34.9
24	4.8		66.6	1.6	0.6		4.0	2.1		194		26		0.6	300.3	21.6
25	3.4				0.7		6.4	2.2							12.7	8.2
26	6.6		1.4		1.5	2.3	25.2	5.0					1.0		43.2	28.0
27	12.1		2.1		14.0	3.1	18.1	46.4					8.5		91.7	59.4
28	17.7		1.2	6.7	8.8	2.0	23.5	29.3					4.0		93.2	60.4
29	5.7		0.1	3.3	2.2		24.3	7.1				53			95.7	62.0
30	0.6		0.1		1.1		24.3	3.5							29.6	19.2
31	13.1		2.2	1.1	2.8	3.3	10.4	9.4					1.4	0.6	44.3	28.7
32	19.1		3.8		10.3	5.5	17.8	34.0					7.2	16.2	113.9	73.8
33	41.7		6.2		29.0	9.1	26.9	95.8					18.8	3.6	230.1	149.0
34	13.8		1.3	3.3	12.4	2.0	12.4	41.2		9	13		6.3	13.7	128.4	83.2
35	1.4		0.1		2.1		17.8	6.9							28.3	18.3
36	1.7		0.1		1.5		17.8	5.1				39			65.2	42.2
37	1.0		2.1	2.0	0.9		10.4	2.9		179				5.1	203.4	14.6
38	0.1		2.0		0.6		6.4	2.1		323					334.2	24.0
39	26.6		4.3	0.5	8.4	6.3	18.2	27.8		9			4.9	12.5	118.5	76.7
40	23.6		4.1	1.7	25.8	5.9	13.4	85.2					17.8	1.4	178.9	115.9
41	17.8		4.4	1.7	53.6	6.4	11.3	177.3		6		1	35.2	3.1	317.8	205.8
42	4.6	21.9	1.2	1.7	30.1	1.9	11.6	99.8		163	131		17.9	5.5	490.2	317.5
43	7.4		0.9	3.1	14.7	1.4	17.7	47.3	20.6					22.2	135.3	87.6
44	4.5		0.1	1.3	5.3	0.1	29.9	17.5		170				5.3	234.0	151.6
45	6.7	4.6	2.0	1.5	6.7		6.4	22.1		75	250			2.1	377.1	27.1
46	18.0		0.5		1.9	0.7	10.1	6.2		108			0.4	3.2	149.0	96.5
47	15.6		2.6		8.8	3.9	18.5	29.1		2			4.9	0.1	89.5	58.0
48	8.4		2.8		8.6	4.1	15.9	28.5		60		2	5.0	49.1	184.4	119.4
49	10.1		2.8		13.0	4.1	13.4	43.1					6.7		93.2	60.4
50	27.8		5.3		9.0	7.8	34.1	29.9						1.4	115.3	74.7
51	28.4		1.3		2.4	2.3	44.7	7.8		28				10.5	125.4	81.2
52	0.2		0.1							22					22.3	14.4
53	1.1		1.7		3.4	2.3	2.4	11.4		22				0.3	44.6	28.9

Table 1.3 (continued). EMISSIONS SUMMARY BY GRID, RENO, 1980 (ton/yr)

Grid	Stationary			Mobile			Fugitive dust								Total ton/yr	Emiss. dens., ton/mi²/yr
	Fuel comb.	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy. exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Str. sand	Var. fugit. sourc.		
54	1.2		0.3		2.0	0.6	4.4	6.6		22				0.1	37.2	24.1
55	1.8		0.2		5.1		3.2	16.9						12	39.2	25.4
56	6.5		1.0		3.6	2.0	65.7	12.0							90.8	58.8
57	13.3		1.3		1.7	2.2	31.9	5.6		22					78.0	50.5
58	1.5		0.6		0.3	1.0	18.8	0.8		86					109.0	70.6
59	0.5				0.2		6.4	0.7		57					64.8	42.0
60	3.4		0.6		0.5	1.0	18.8	1.4		229				7	261.7	169.5
61	1.8		0.6		0.2	1.0	18.8	0.6		157					180.0	116.6
Tot.	428.3	26.6	1105.2	42.0	386.6	94.3	899.2	1277.9	20.63	969.0	460.0	131.0	140.0	180.6	9151.3	

Table 1.4. EMISSIONS SUMMARY BY GRID, RENO, 1985

(ton/yr)

	Stationary			Mobile			Fugitive dust—									
Grid	Fuel comb.	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy. exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Str. sand	Var. fugit. sourc.	Total ton/yr	Emiss. dens., ton/ mi^2/yr
1																
2																
3	0.7		148.8		8.0		0.8	33.0		162					353.3	25.4
4	0.7		148.8		0.5		0.8	2.0		205					357.8	25.7
5			74.3							65					139.3	10.0
6																
7										11					11.0	0.8
8	1.3		148.9		7.2		6.6	29.7		258					451.7	32.5
9	8.1		149.2		10.9	1.0	15.5	44.9		205					434.6	31.3
10	0.3		74.3		0.9			3.6		226	66				371.1	26.7
11																
12			2.0							108					110.0	7.9
13	5.4		124.6		6.3	1.2	12.6	26.1		129					305.2	22.0
14	19.5		51.1		14.2	3.9	101.2	58.6		86					334.5	24.1
15			74.3		0.5			1.9		162					238.7	17.2
16	2.4		2.2	7.9	12.6	0.1	7.2	51.9		86				3.4	173.7	12.5
17	8.9		2.5	6.6	12.4	0.9	12.9	51.1		258				2.6	355.9	25.6
18	1.3				0.4			1.7		43					46.4	30.1
19	0.9				1.0		7.2	4.0							13.1	8.5
20	3.4				4.2			17.3							24.9	16.1
21	8.7		1.4		9.4	2.9	60.3	39.0							121.7	78.8
22	1.2				1.9		14.4	7.7							25.2	16.3
23			0.1		0.4	0.7	27.2	1.7		22					52.1	33.7
24	5.8		41.5	1.8	0.9		4.4	3.8		194		26		0.6	278.8	20.1
25	3.4				1.1		7.2	4.4							16.1	10.4
26	7.8		1.6		1.4	2.7	28.2	5.6					1.0		48.3	31.3
27	13.1		2.4		13.1	3.3	20.3	54.2					8.5		114.9	74.4
28	20.1		1.4	8.3	9.8	2.3	26.3	40.5					4.0		112.7	73.0
29	10.4		0.1	4.2	2.0	0.7	27.2	8.5				53			106.1	68.7
30	1.1		0.1		1.3	0.7	27.2	5.3							35.7	23.1
31	13.6		2.5	1.3	3.0	3.4	11.6	12.5					1.4	0.6	49.9	32.3
32	19.9		4.2		8.5	5.7	20.0	35.3					7.2	16.2	117.0	75.8
33	43.3		6.9		25.6	9.4	30.3	105.7					18.8	2.6	242.6	157.1
34	15.0		1.5	4.2	13.0	2.2	13.8	53.8		9			6.3	13.7	132.5	85.8
35	2.4		0.1		2.0	0.6	20.0	8.3							33.4	21.6
36	2.9		0.1		1.5	0.6	20.0	6.4				39			70.5	45.7
37	1.7		2.1	2.3	0.9		11.6	3.7		179				5.1	206.4	14.8
38	0.1		2.0		1.0		7.2	4.2		323					337.5	24.3
39	27.7		4.8	0.6	8.0	6.6	20.5	33.1		9			4.9	12.5	127.7	82.7
40	24.4		4.6	1.9	21.6	6.1	14.9	89.5					17.8	1.4	182.2	118.0
41	18.2		5.0	2.0	46.9	6.6	12.7	193.9		6		1	35.2	3.1	330.6	214.1
42	4.9		1.4	1.9	28.6	2.0	13.0	118.3		27			17.9	5.5	220.5	142.8
43	8.7		1.0	3.6	14.2	1.6	19.9	57.3	20.6					22.2	149.1	96.6
44	7.9		0.1	1.6	5.0	0.9	33.4	20.8		170				5.3	245.0	158.7
45	6.7	5.2	2.0	1.7	7.0		7.2	29.0		75	250			2.1	385.9	27.8
46	21.1		0.6		2.6	0.8	11.3	10.6		108			0.4	3.2	158.6	102.7
47	20.8		3.0		8.7	4.2	20.7	36.1		2			4.9	0.1	100.5	65.1
48	8.8		3.1		8.2	4.3	17.7	34.0		60		2	5.0	49.1	192.2	124.5
49	10.6		3.1		13.5	4.3	15.1	55.8					6.7		109.1	70.7
50	28.9		5.9		7.0	8.3	38.3	28.9						1.4	118.7	76.9
51	35.2		1.5		1.9	2.9	50.2	7.9		28				10.5	138.1	89.4
52	0.2		0.1							22					22.3	14.4
53	1.1		1.9		3.8	2.4	2.6	15.7		22				0.3	49.8	32.3
54	1.3		0.4		2.8	0.6	5.0	11.4		22				0.1	43.6	28.2
55	2.0		0.2		5.8		3.5	23.8						12	47.3	30.6
56	8.9		1.1		4.2	2.9	73.7	17.3							108.1	70.0
57	15.5		1.5		1.8	2.6	35.8	7.5		22					86.7	56.2
58	1.9		0.6		0.3	1.2	21.1	1.2		86					112.3	72.7
59	0.5				0.3		7.2	1.1		57					66.1	42.8
60	4.3		0.6		0.6	1.2	21.1	2.1		229				7	265.9	172.2
61	2.3		0.6		0.3	1.2	21.1	1.0		157					183.5	118.8
Tot.	480.4	5.2	1112.5	49.9	369.0	105.3	1008.0	1522.7	20.6	3833.0	316.0	121.0	180.6	180.6	9264.2	

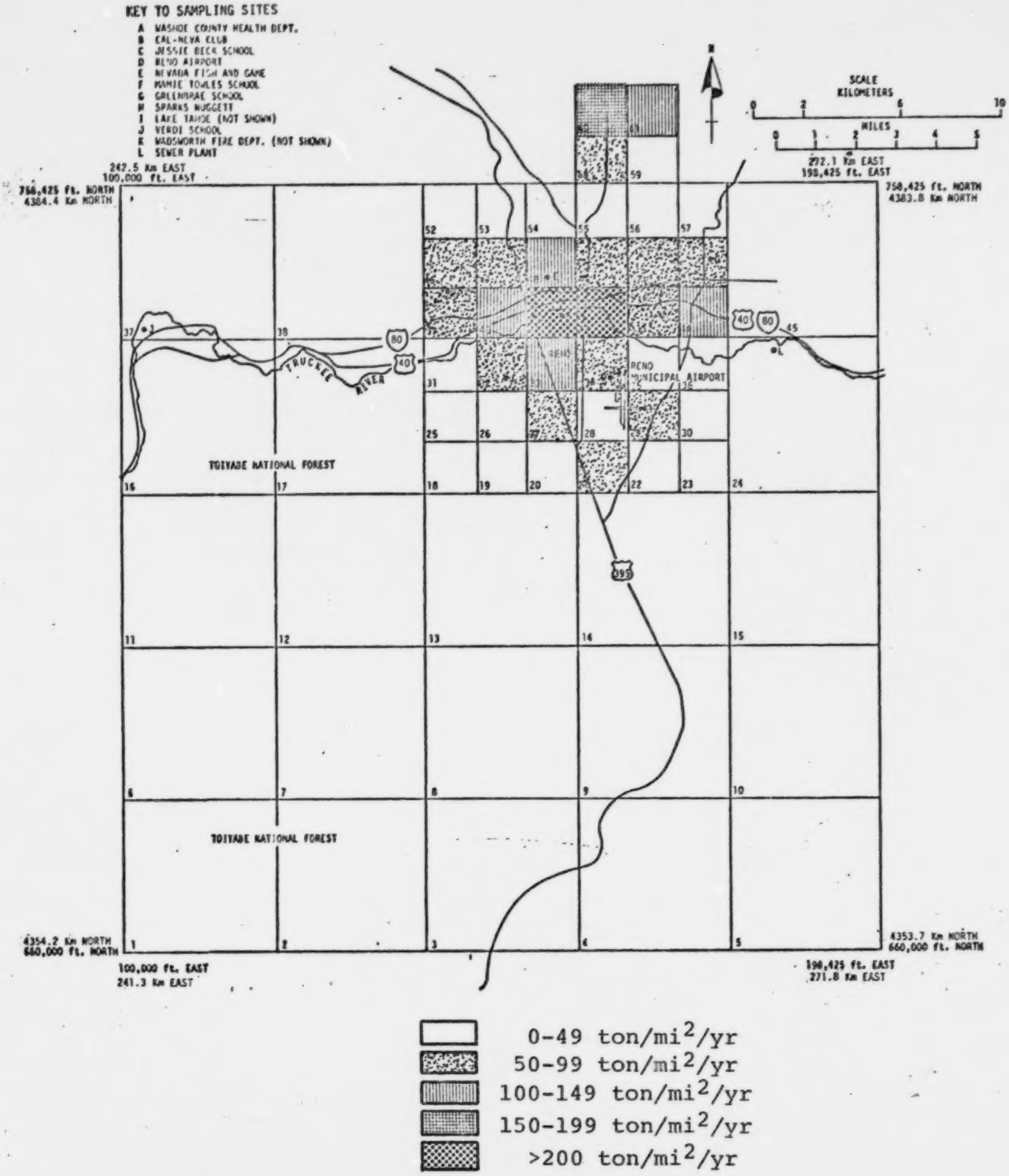
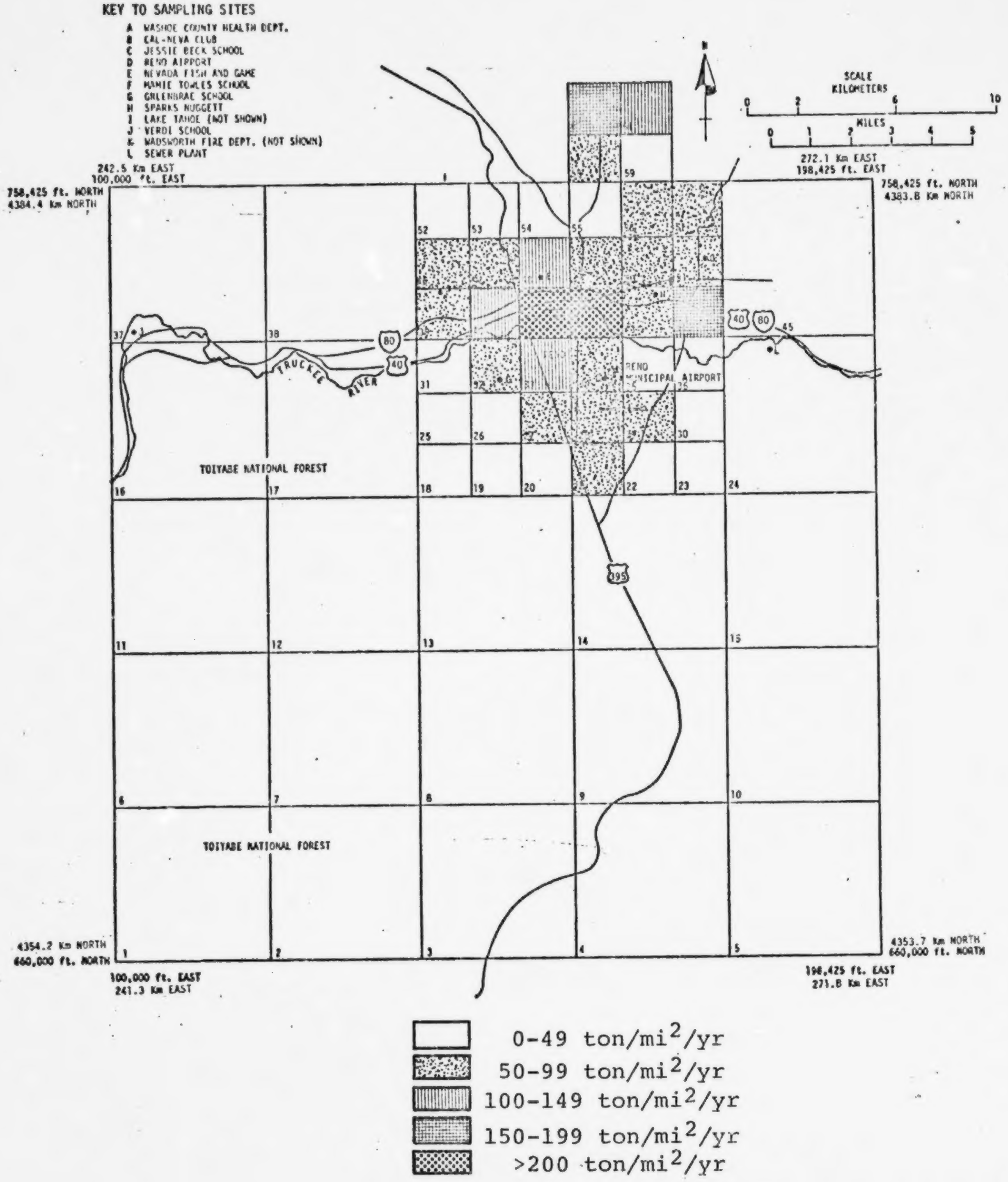

KEY TO SAMPLING SITES
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
242.5 Km EAST
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
N
SCALE
KILOMETERS
0 2 6 10
MILES
0 1 2 3 4 5
272.1 Km EAST
190,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
TRUCKEE RIVER
80
40
RENO
RENO MUNICIPAL AIRPORT
395
TOIYABE NATIONAL FOREST
4354.2 Km NORTH
660,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH
190,425 ft. EAST
271.8 Km EAST
0-49 ton/mi2/yr
50-99 ton/mi2/yr
100-149 ton/mi2/yr
150-199 ton/mi2/yr
>200 ton/mi2/yr

Figure 1.2 1975 Reno particulate emission density, ton/mi^2/yr.


KEY TO SAMPLING SITES
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
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K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
242.5 Km EAST
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
SCALE
KILOMETERS
0 2 6 10
MILES
0 1 2 3 4 5
272.1 Km EAST
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758,425 ft. NORTH
4383.8 Km NORTH
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TRUCKEE RIVER
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RENO MUNICIPAL AIRPORT
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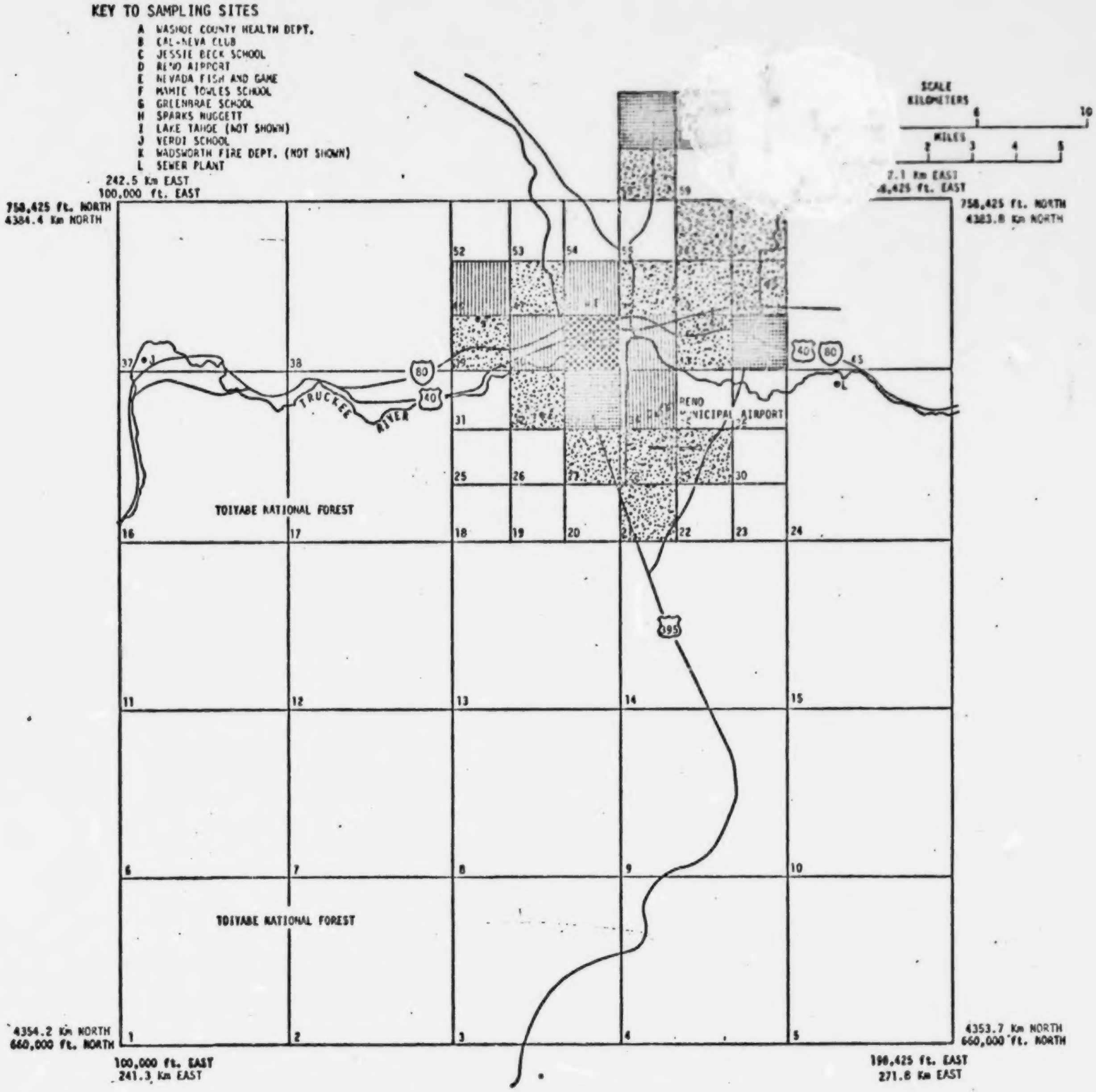
660,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST
0-49 ton/mi²/yr
50-99 ton/mi²/yr
100-149 ton/mi²/yr
150-199 ton/mi²/yr
>200 ton/mi²/yr

Figure 1.3 1980 Reno particulate emission density, ton/mi^2/yr.


KEY TO SAMPLING SITES
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2.1 Km EAST
8,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
TRUCKEE RIVER
80
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RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
4354.2 Km NORTH
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100,000 ft. EAST
241.3 Km EAST
190,425 ft. EAST
271.8 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH

☐ 0-49 ton/mi^2/yr

▨ 50-99 ton/mi^2/yr

▥ 100-149 ton/mi^2/yr

▦ 150-199 ton/mi^2/yr

▩ >200 ton/mi^2/yr

Figure 1.4 1985 Reno particulate emission density, ton/mi^2/yr.

2. EMISSION CALCULATION PROCEDURES

In this chapter, methods have been outlined for determining total annual area source emissions for all source categories in the Reno study area.

STATIONARY FUEL COMBUSTION

Emissions totals due to fuel combustion of all residential, commercial, institutional, and industrial sources have been calculated and provided for this study by Sierra Environmental Monitoring.[1]

Emissions were transferred from the grid system used in the Sierra survey to the grid system used in this study. Since the boundaries of these grid systems do not completely correspond, some fuel combustion emissions were added to specific peripheral grids which are not covered by the Sierra system.

Projections - The figures supplied by the Sierra survey do not indicate the percentage or quantity of emissions which can be attributed to residential, commercial/institutional, and industrial sources, respectively. Therefore, total emissions were projected based on population, since the greater part of these emissions (residential and commercial/institutional) are directly related to population. Total emissions are shown in Table 2.1.

Allocations - Emissions were allocated to grids used in this study as described above.

Further explanation of projections and allocations by population is given in Section 3.

Table 2.1 STATIONARY FUEL COMBUSTION EMISSION FROM AREA SOURCES IN THE RENO STUDY AREA

	1975	1980	1985
Growth factor	--	1.104	1.238
Emissions, tons/year	388.2	428.3	480.4

INDUSTRIAL PROCESSES

Most industrial processes which have significant emissions have been indicated as point sources on National Emissions Data System (NEDS) forms.[2] Total emissions for this category were taken from these forms for Reno which amounted to 23 tons/year.

Projections - Emissions were projected based on manufacturing dollars earned from 1972 Obers projections.[3] The growth factors and emissions are shown in Table 2.2. Note, however, that a major sand and gravel pit operation will be replaced in 1985 by a hotel complex, thus reducing the process emissions significantly.

Table 2.2 INDUSTRIAL PROCESS EMISSIONS IN RENO

	1975	1980	1985
Growth factor	-	1.155	-
Emissions (tons/year)	23.0	26.6	5.2

Allocations - Emissions were allocated to grid based on the UTM coordinates of each source obtained from the NEDS forms.[2] A list of these sources is given in Appendix A.

BURNING

In this category, emissions from wildfires, structural fires, controlled burning, and incineration were determined for the Reno study area. The following offices were contacted to obtain the required information: The Bureau of Land

Management,[5] the U.S. Forest Service,[6] and the fire departments of Reno,[7] Sparks,[8] and Truckee Meadows.[9] These agencies reported a combined total of 719 structural fires and 183.4 acres of land burned. Assuming 5 tons of wood burned per structural fire (an engineering judgment of PEDCo-Environmental), and applying an emission factor of 17 lb emitted per ton burned,[10] emissions from structural fires in the Reno study area were

$$(719 \text{ fires})(5 \text{ tons/fire})(17 \text{ lb/ton})(\text{ton}/2000 \text{ lb}) = 30.6 \text{ tons emitted} \quad (1)$$

Applying an emission factor of 136.5 lb emitted per acre burned to the 183.4 acres burned in Reno gives 12.5 tons emitted.

Emissions from incineration amounted to 24.0 tons and controlled open burning accounted for 1,032.4 tons of emissions. This information was provided by the Washoe County District Health Department.[11] Total emissions from burning amount to 1,099.5 tons per year.

Projections - Emissions from burned acreage, controlled and uncontrolled, were projected at the same level as the current values since there is no accurate method for estimating the potential for open burning and wildfires. Emissions from structural fires and incineration were projected by population. These emissions are shown in Table 2.3.

Allocations - Emissions from acreage burned were allocated to non-populated grids, while structural fire and incineration emissions were apportioned by population.

Further explanation of projections and allocations by population is given in Section 3.

Table 2.3 EMISSIONS FROM BURNING IN RENO

	1975	1980	1985
Structural fire emissions (tons/yr)	30.6	33.8	37.9
Burned acreage emissions (tons/yr)	12.5	12.5	12.5
Incineration emissions (tons/yr)	24.0	26.5	29.7
Controlled burning emissions (tons/yr)	1,032.4	1,032.4	1,032.4
Total emissions (tons/yr)	1,099.5	1,105.2	1,112.5

MOBILE SOURCES

In this section, methods have been outlined for determining total annual area source emissions for all mobile source categories (aircraft, railroad, highway, and off-highway) in the Reno study area.

Aircraft

Emissions due to aircraft operations were calculated in the following manner:

$$EA = (LTO)(ENG)(EF)$$

where

EA = Annual emissions for a given aircraft type
LTO = Annual number of landing-takeoff cycles for that aircraft type
ENG = Number of engines on that aircraft type
EF = Emission factor, usually given in lb/engine-LTO

These emissions are then summed over all aircraft types in operation at a given airport to determine the annual emissions from that airport.

The effect of aircraft upon the air quality in the Reno study area is limited to the one airport of significant size, Reno International. All aircraft operation data[12] and the corresponding emissions are shown in Table 2.4.

Table 2.4 AIRCRAFT EMISSIONS IN RENO 1975

Airport	Aircraft type	ENG	LTO	Total ENG-LTO	EF (lb/ENG-LTO)	EA (tons/year)
Reno International	Long range jet	4	1,095	4,380	1.21	2.7
	Medium range jet	2 3	3,650 6,570	27,010	0.41	5.5
	Air carrier turboprop	2	730	1,460	1.10	0.8
	Air Carrier piston	1	1,095	1,095	0.02	neg.
	Military jet	1	4,500	4,500	0.31	0.7
	Business jet	2	3,109	6,218	0.11	0.3
	General aviation	1 2 4	46,294 11,815 933	73,656	0.02	0.7
						10.7

Projections - Projected emissions are based on LTO projections per aircraft type supplied by Reno International.[13] The projected emissions are shown in Table 2.5.

Table 2.5 PROJECTED AIRCRAFT EMISSIONS IN RENO

Airport	1975	1980	1985
Reno International			
Growth factor	-	1.243	1.561
Emissions	10.5	13.3	16.7

Allocations - Aircraft emissions were allocated to the grids occupied by Reno International.

Railroads

Emissions due to railroad activity in the Reno study area were calculated as follows:

$$EG = (TMG)(GMD)(DPY)(EF)(CF) \qquad (3)$$

where

EG = annual emissions in tons per year of a given grid

TMG = number of miles of track in that grid

GMD = fuel usage rate in gallons per mile per day; estimated to be 251 gal/mi/day on the line west of Reno, and 155 gal/mi/day on the line east of Reno based on information received from Southern Pacific Transportation Company.[14]

DPY = days per year, 365

EF = emission factor found in EPA publication AP-42;[10] 0.025 lb/gal.

CF = correction factor; 0.0005 tons/lb

Substituting the appropriate values equation (3) becomes

$$EG = (TMG)(1.145 \text{ tons/mile of track west of Reno}) \qquad (4)$$

$$EG = (TMG)(0.7072 \text{ tons/mile of track east of Reno}) \qquad (5)$$

Engines used for switchyard operations in the Reno-Sparks area average 8 gallons per hour each. Two switch engines are operated per 8 hour shift, 3 shifts per day, 7 days per week. One engine switches a total of 20 hours per week in Reno (4 hours per day, 5 days per week). The balance of this switch engine time is at Sparks.[14] Emissions were calculated accordingly in grids where switchyard operations were significant.

Also a single line running north out of Reno, owned and operated by Western Pacific, carries one locomotive per day. This engine consumes an average of 2 gallons per mile over 44 miles of track (22 miles each way from Reno to the State line), and travels approximately 5 miles during switching operations.[15] The total fuel usage on this line is then 98 gallons per day.

Total area emissions are the sum of the individual grid emissions.

Projection - These emissions were projected based on rail activity growth rates also supplied by Southern Pacific. These are shown in Table 2.6.

Allocations - Emissions were allocated to the grids as they were calculated following the procedure outlined above.

Table 2.6 EMISSIONS DUE TO RAILROAD ACTIVITY IN RENO

	1975	1980	1985
Growth factor	-	1.159	1.344
Emissions, tons/yr	24.71	28.65	33.21

Highway Vehicles

1975 daily VMT data was supplied by the State of Nevada Department of Highways, Planning Survey Division in Carson City.[16] The data was presented for each grid shown on the Department of Highways map and combined for the grid system used in this study. Both grid systems are aligned to the state plane coordinate system. An emission factor of 0.594

grams per mile was applied to the total VMT to obtain annual emissions in tons per year. This is a weighted emission factor based on standard emission factors[10] and percentage of VMT traveled by each vehicle type as shown below. The percentages of travel by vehicle type are estimates of PEDCo-Environmental based on information obtained from the Nevada Department of Highways.[17]

Light-duty gasoline-powered vehicles contribute
0.54 grams/mile over 94 percent of VMT = 0.508 g/mi
Heavy-duty gasoline-powered vehicles contribute
1.21 grams/mile over 4 percent of VMT = 0.048 g/mi
Heavy-duty diesel-powered vehicles contribute
1.90 grams/mile over 2 percent of VMT = 0.038 g/mi
Total weighted emission factor = 0.594 g/mi (6)

Total area emissions are the sum of the emissions by grid as calculated in equation 7. For example:

1975 annual emissions in
grid 27 (tons/year) = 68,312 VMT/day times
365 days/year times
0.594 grams/mile times
0.0022 lbs/gram times
0.0005 tons/lb
= 16.3 tons/year (7)

Projections - Due to the expected continued usage of unleaded fuel, highway vehicle particulate emission factors are expected to drop off in future years. The emission factors for light-duty gasoline-powered vehicles for 1980 and 1985 will be 0.36 grams/mile and 0.27 grams/mile, respectively. These are weighted factors based on the percent of travel by vehicles using leaded and unleaded fuels and their respective average emission factors found in supplement 5.[32] The emission factors for both gasoline and diesel powered heavy-duty vehicles will remain the same for future years. Overall emission factors were calculated for the future years in the same manner as that for 1975 in equation 6. The emission factors for 1980 and 1985 are 0.425 grams/mile and 0.340 grams/mile, respectively.

1980 and 1985 emissions were based on a straight-line interpolation between 1975 and 1995 daily VMT per grid provided by the State Department of Highways.[16] The 1995 daily VMT were for alignment "A" of the proposed U.S. 395. From these alignments suggested by the Department of Highways alignment "A" was selected for use in this study based on conversations with the Nevada Department of Human Resources[28] and the Washoe County District Health Department.[29] Emissions are shown in Table 2.7.

Allocations - Emissions for each year by grid were calculated using the VMT in each grid. Total area emissions are the sum of the emissions by grid.

Table 2.7 HIGHWAY VEHICLE EMISSIONS IN THE RENO VALLEY

	1975	1980	1985
Emission factor, grams/mile	0.594	0.425	0.340
Annual emissions, (tons/year)	437.3	386.6	369.0

Off-Highway

Off-highway emissions in the Reno study area were calculated following the method outlined in EPA publication APTD-1135.[18] Gasoline usage is estimated to be 13 gallons per capita, mainly from the operation of 2 and 4-stroke lawnmowers and garden tractors. Gasoline usage by farm tractors and heavy-duty gasoline-powered equipment was negligible due to the minimal number of vehicles of this type. Therefore, emissions from off-highway gasoline usage is calculated as follows:

Annual off-highway gasoline emissions
(tons/year) = 135,520 population times
13 gallons per capita times
42.9 lb/1000 gallons times
0.0005 tons/lb
= 37.8 tons/year (8)

Diesel usage is estimated to be 7.4 gallons per capita and 5,000 gallons per non-building construction employee.[19] Diesel usage by farm tractors is negligible. Therefore, emissions from off-highway diesel usage, mainly by heavy-duty construction equipment and heavy-duty utility engines is calculated as follows:

Annual diesel usage (gallons)
= 135,520 population times
7.4 gallons per capita
plus
530 non-building construction employees times
5,000 gallons per non-building construction employees
= 3,652,848 gallons per year (9)

Annual off-highway diesel emissions
(tons/year) = 3,652,848 gallons per year times
26.1 lb/1000 gallons times
0.0005 tons/lb
= 47.7 tons/year (10)

Total gasoline and diesel off-highway
emissions (tons/year) = 85.5 tons/year

Projections - Emissions were projected based on the increase in population and the increase in the number of non-building construction employees proportional to the population. These parameters and corresponding emissions are shown in Table 2.8.

Table 2.8 OFF-HIGHWAY GASOLINE AND DIESEL EMISSIONS IN THE RENO STUDY AREA

	1975	1980	1985
Population	135,520	149,600	167,800
Non-building construction employees	530	585	656
Gasoline emissions (tons/year)	37.8	41.7	46.8
Diesel emissions (tons/year)	47.7	52.6	59.0
Total emissions (tons/year)	85.5	94.3	105.8

Allocations - Emissions for each year were allocated to grids by population.

Further explanation of projections and allocations by population is given in Section 3.

FUGITIVE DUST

In this section methods are outlined for calculating emissions from all sources of fugitive dust in the Reno study area.

Construction

A list of building permits for Reno was supplied by the Washoe County District Health Department.[20] The permits were grouped into three categories: residential (including apartments and condominiums), commercial/institutional, and industrial. It was assumed that most of the projects were constructed on a fraction of the total acreage available and that surface disturbance occurred only during a portion of the time allowed by the permit. It was assumed that residential construction occurred on one-sixth acre for three months, commercial/institutional construction occurred on one-fourth acre for six months, and industrial construction occurred on one-fourth acre for eight months.[21] The number of projects in each category and the corresponding acreage and construction times are shown in Table 2.9.

Table 2.9. CONSTRUCTION PROJECTS IN RENO 1975

Category	No. projects	Acres	Months	Acre-months
Residential	654	.16	3	327
Commercial/ Institutional	212	.25	6	318
Industrial	1	.25	8	4
Total				649

Also, 165 acre-months of highway construction were estimated to be done in Reno in 1975.[22,23]

Applying an emission factor of 1.0 ton/acre-month,[25] total emissions from all construction is 814 tons per year.

Projections - Emissions due to construction in the Reno study area were projected by population. These are shown in Table 2.10.

Allocations - Construction emissions were allocated to grids by the change in population. That is, the emissions in each grid for 1975 were obtained by multiplying total construction emissions by the ratio of the change in the grid population from 1975 to 1980 to the change in the study area population from 1975 to 1980. Similar calculations were made for 1980 and 1985 emissions. Highway construction and population growth were observed to follow the same geographical patterns thereby justifying the allocation of highway construction emissions by population.[24]

Table 2.10 EMISSIONS DUE TO CONSTRUCTION IN RENO

	1975	1980	1985
Growth factors	-	1.104	1.238
Emission, tons/year	814.0	899.0	1008.0

Normal Paved Streets

Fugitive dust emissions from normal paved streets are proportional to the VMT on all streets classified as "normal" in the study area. The VMT used in this section were determined from those used in the section on Highway Vehicles. The VMT used in the Highway Vehicle section are totals of the VMT on both paved and unpaved roads. The VMT on paved roads includes that both "normal" and "dirty" streets. Care was taken to use only those VMT on normal paved streets for calculations in this section.

As in the section on highway vehicles emissions were calculated by grid, and the total emissions were the sum of all grid emissions. An emission factor of 1.75 grams/mile[23] (corrected for 71 days of precipitation) was applied to the VMT in each grid to obtain the emissions from each grid. The adjusted emission factor is 1.41 grams/mile.

Projections - 1980 and 1985 emissions were based on a straight-line interpolation between 1975 and 1995 daily VMT provided by the State Department of Highways.[16] Total emissions for these study years are shown in Table 2.11.

Allocations - Emissions were allocated to each grid as they were calculated for each grid. Total emissions are the sum of the grid emissions for each year.

Table 2.11 FUGITIVE DUST EMISSIONS FROM NORMAL PAVED STREETS IN THE RENO STUDY AREA

	1975	1980	1985
Emission factor, grams/mile	1.41	1.41	1.41
Emissions, ton/year	1,034.1	1,277.9	1,522.7

Dirty Paved Streets

Local streets in the downtown area of Sparks were identified as dirty paved streets. The total VMT on local streets were obtained from the Department of Highways[17] and it was estimated that 50 percent of the local travel occurred on dirty streets. The resulting estimate of travel on dirty paved streets was 2266 VMT daily in grid 43 in 1975.

The emission factor for dirty paved streets is 28 gm/VMT on days with no precipitation.[25] Correcting for 71 days of precipitation, the annual average emission factor is 22.6 gm/VMT. The resulting 1975 annual emissions are, therefore, 20.6 tons/yr.

Projections - It was assumed that these streets would remain classified as "dirty" for the projection years 1980 and 1985, and that there would be no increase in VMT on these roads. Therefore, emissions were projected at the same level as the base year.

Allocations - Emissions were allocated to the grids as described above.

Unpaved Roads

Unpaved roads were identified in the urban area by a general survey via automobile during the microinventory of each hi-vol site.[25] In the more rural parts of the study area, unpaved roads were identified from highway maps prepared by the State Department of Highways.

For unpaved roads identified in the microinventories, VMT were calculated from estimated average daily traffic and road lengths measured from U.S.G.S. maps. For unpaved roads identified from highway maps, VMT were calculated by assuming a typical ADT of 25 vehicles per day. Care was taken not to include the same unpaved roads identified in the microinventory with the unpaved roads measured from the highway maps. It is recognized that the highway maps used are somewhat dated; however, these maps are the most current available which show road surface type. Also, meetings with the Department of Highways of both Washoe County and the State of Nevada revealed that there is no information available which is more current.

An emission factor of 4.7 lb/VMT was calculated based on soil type (gravel assumed), precipitation (71 days), and average vehicle speed (30 mph).[25] This value was adjusted according to the average vehicle speed on each unpaved road. Total emissions in the study area amounted to 3,969 tons/year.

Projections - Emissions from unpaved roads were assumed to remain the same for 1980 and 1985. As traffic on an unpaved road increases, the road is often times paved. It is assumed in these projections that VMT on unpaved roads eliminated by paving programs would be approximately off-set by increases in VMT on new and existing unpaved roads in the study area.

Allocations - The emissions were allocated to the grids in which the unpaved roads are located.

Sand and Gravel Pits

Sand and gravel operations were identified during the microinventory surveys around the hi-vol sites[25] and by a general area-wide survey. These operations were located on U.S.G.S. maps in order to determine the area involved more accurately. The sand and gravel pits were identified as active or inactive, having emission factors of 1.9 tons/acre/year and 0.64 tons/acre/year, respectively.[25] Total emissions due to sand and gravel operations in Reno in 1975 were 460 tons.

Projections - Sand and gravel operations were expected to remain fairly constant over the next ten years. Therefore, emissions from each source were projected at the same level for 1980 and 1985. However, one particular operation north of the airport will be closed down by 1985 and replaced by a hotel complex. Thus, emissions from this source in grids 34 and 42 will be zero in 1985.

Allocations - Emissions were allocated to grids where sand and gravel operations were identified.

Agriculture

Agricultural fields were identified during the micro-inventories. Additional information regarding total acreage and crop type was obtained from the Washoe County agricultural agent[26] and the University of Nevada College of Agriculture.[27]

Emissions from agricultural fields are twofold: those from tilling operations and those from windblown dust. The emission factor for tilling is 7.0 s lb/acre/tilling operation,[25] where s is the silt content of the soil. Since very little farming is done in the Reno Valley, and most crops are only forage, tilling operations are assumed to be done only once each year. Assuming the silt content of the soil to be 40 percent[26] in most of the farmed areas in Reno, the emission factor becomes approximately 280 lb/acre/year, or 0.140 tons/acre/year.

The emission factor for windblown dust is dependent on a variety of parameters including soil erodibility, surface roughness, climatic data, and vegetative cover.[25] No single emission factor was applicable to all agricultural areas totalling 329.2 acres. Therefore, emission factors, depending particularly on crop type, were determined as follows:

0.071 tons/acre/year from 250 acres, 0.066 tons/ acre/year from 62.9 acres, and 0.0027 tons/acre/year from 16.3 acres.

Applying these emission factors to the agricultural land in the Reno Valley, total emissions amount to 121 tons/year.

Projections - Agricultural operations are not expected to increase in the Reno study area to any significant degree. Therefore, emissions were projected at the same level.

Allocations - Emissions were allocated to grids according to the location of the agricultural acreage.

Street Sanding

Approximately 350 cubic yards of red cinder are used for snow control in Reno each year.[30] Based on information found in Marks Mechanical Engineering Handbook,[31] PEDCo-Environmental estimated the density of red cinder to be 60 pounds per cubic foot. Therefore, the amount of red cinder used was approximately 280 tons. Assuming 50 percent of this material becomes airborne, emissions from street sanding for snow control in Reno are 140 tons/year.

Salt is used for snow control in Sparks. It is assumed that all salt is washed off of the roads, and, therefore, there are no emissions from street salting.

Projections - It is assumed that approximately the same amount of red cinder is used each year in Reno. Therefore, the emissions were projected at the same level.

Allocations - Street sanding for snow control in Reno is limited to the more heavily traveled roads. Emissions were allocated to grids based on the VMT in the grids designated as heavily traveled.

Various Fugitive Dust Sources

The fugitive dust sources included in this category are:

- Cleared areas,
- Playgrounds,
- Unpaved parking lots,
- Railroad right-of-ways and yards,
- Heavy equipment storage,
- Road shoulders, and
- Horse corrals.

These sources were identified in the microinventories around the hi-vol sites and by a general area-wide survey. They were located on the appropriate U.S.G.S. map and labeled with pertinent data, such as size and boundaries, observed activity, and any other important parameters. Emission factors were obtained from the Task B Report[25] and applied to estimate annual emissions. The 1975 emissions were allocated to the grids in which they were identified and projected as constant for 1980 and 1985. Emissions for the various fugitive dust categories by grid are given in Appendix B.

Cleared Areas - The emission factors for cleared areas account for soil type, vegetation, and traffic. The factors are as follows:

	Emission factor, ton/acre/yr			
	Vegetation			
Soil type	None	Sparse	Moderate	Heavy
Rocky or demolition waste	0.19	0.13	0.06	0.01
Sandy	0.30	0.23	0.16	0.03
Fine	0.55	0.44	0.34	0.09
Clay foam	0.24	0.18	0.11	0.02

For occasional traffic (1 veh/day), multiply the value by 1.05 and for regular traffic (5 veh/day), multiply the value by 1.20. The total annual emissions from this category are 40 tons/yr.

Playgrounds - Emissions were calculated for playgrounds only where their proximity to the hi-vol location would influence readings. The emission factor for this category is 1.5 ton/acre/yr and the total annual emissions are 51 ton/yr.

Unpaved Parking Lots - Emission factors were developed for either vehicle usage or surface area of unpaved parking lots. Where VMT on an unpaved parking lot could be estimated (from average number of vehicles and average distance driven), emissions were calculated from the VMT. Where VMT on a lot could not be estimated, dimensions of the lot were used to estimate emissions. The emission factors for this category are 1.6 lb/VMT when traffic estimates could be made, and 0.15 ton/yr per 10,000 sq ft when only the area could be determined. The total annual emissions from unpaved parking lots is 39 ton/yr.

Railroad Right-of-Ways and Yards - This category was identified by both the microinventory and U.S.G.S. maps. Lengths were taken from U.S.G.S. maps for rail lines. Widths of single track lines were estimated at 12 ft and double track lines at 24 ft. The area of rail yards were estimated from U.S.G.S. maps. The emission factor for this category is 0.2 ton/acre/yr and the estimated total annual emissions are 36 ton/yr.

Heavy Equipment Storage - Sources in this category were also identified in the microinventory. The emission factor is 0.30 ton/acre/yr and the estimated annual emissions from heavy equipment storage yards are 3 ton/yr.

Road Shoulders - Upon conversations with State, county, and local highway departments, it was determined that data are not available that would enable the identification of unpaved road shoulders in the study area. Therefore, only road shoulders with regular traffic were identified in the microinventories. For those road shoulders so identified, estimates of traffic volume were made. The emission factor is 1.6 lb/VMT and the total emissions from this category are 3 ton/yr.

Horse Corrals - Horse corrals were identified during the microinventories. An emission factor of 3 ton/acre/yr was used to estimate total annual emissions of 9.0 ton/yr.

3. PROJECTIONS AND ALLOCATIONS BY POPULATION

In this section, the methods for projecting and allocating emissions by population and the justification for doing so are outlined.

Projections of area-wide emissions by population are obtained by multiplying the base year (1975) emissions by the ratios of the populations of the projection year to the base year. These ratios may also be referred to as growth factors. For the Reno study area, the population growth factors are calculated as follows:

$$\text{1980 growth factor} = \frac{\text{1980 Reno population}}{\text{1975 Reno population}}$$

$$= \frac{149{,}600}{135{,}520} = 1.104$$

$$\text{1985 growth factor} = \frac{\text{1985 Reno population}}{\text{1975 Reno population}}$$

$$= \frac{167{,}800}{135{,}520} = 1.238$$

These factors are multiplied by the 1975 study area emissions to obtain the 1980 and 1985 study area emissions, respectively, for each category projected by population.

Allocations to grids of area-wide emissions by population are obtained by multiplying the area-wide emissions for a given year by the ratios of the populations of each grid to the area-wide population for that year. These ratios, which are essentially the percentages of the total area-wide emissions contributed by each grid, may also be referred to as allocation or apportioning factors. For the

Reno study area, the population apportioning factors are calculated as follows:

$$\text{1975 grid 1 apportioning factor} = \frac{\text{1975 grid 1 population}}{\text{1975 Reno population}}$$

$$\text{1975 grid 2 apportioning factor} = \frac{\text{1975 grid 2 population}}{\text{1975 Reno population}}$$

and so on for all grids in the Reno study area. Apportioning factors for projection years are calculated in a similar manner:

$$\text{1980 grid 1 apportioning factor} = \frac{\text{1980 grid 1 population}}{\text{1980 Reno population}}$$

$$\text{1985 grid 1 apportioning factor} = \frac{\text{1985 grid 1 population}}{\text{1985 Reno population}}$$

These apportioning factors are multiplied by the area-wide emissions in order to obtain the emissions from each grid in each year, respectively. Grid populations for the base year (1975) were based on population figures by census tracts in the Reno study area. This information was provided by the Regional Planning Commission of Reno, Spark and Washoe County. Grid populations for the projection years were estimates of PEDCo-Environmental based on discussion with the Regional Planning Commission about population growth patterns (the limitations and potential for growth) in specific areas of the Reno study area.

Emissions from the following categories were projected and allocated by population:

- Residential and commercial/institutional fuel combustion,
- Structural fires,
- Off-highway gasoline and diesel fuel combustion,
- Construction.

Emission from residential fuel combustion are obviously proportional to the population or to the number of dwelling units occupied by the population. Commercial/institutional establishments are assumed to be located predominantly in or near population centers. This was verified by a land use map provided by the Regional Planning Commission of Reno, Sparks, and Washoe County.[4] Also, the number of these establishments is assumed to be directly related to the population. Therefore, emissions from commercial/institutional fuel combustion can be allocated and projected by population.

It is a logical assumption that the number of building units or structures in a given area is proportional to the population of the area. This is in agreement with the assumptions on fuel combustion. It also seems logical to assume that the number of structural fires is proportional to the population. The location of future fires cannot be determined to any significant degree of accuracy. Therefore, structural fires are allocated and projected by population in general.

The majority of off-highway gasoline emissions are from lawnmowers and garden tractors used by the general population. Therefore, these emissions can validly be projected and apportioned by population.

Roadway construction is the source of two types of emissions: diesel fuel combustion and fugitive dust. Roadway construction and population growth were observed to follow the same geographical patterns.[4] Therefore, off-highway diesel fuel combustion emissions and fugitive dust emissions from roadway construction (and also building construction) can be projected by population and apportioned by the change in population in each grid.

4. PARTICLE SIZING AND SEASONAL DISTRIBUTION

In this section are presented tables which show the seasonal variation of particulate emissions and the particle size distribution of the annual emissions from fugitive dust sources in the Reno study area. Seasonal variations are shown in Table 4.1 for each quarter of the calendar year. The seasonal adjustment factors are from Table 5.3 of the Task B Report.[25] The seasonal distribution of fuel combustion emissions is also shown since this data has been provided in this form by Sierra Environmental Monitoring[1] for this report.

The particle size distribution is shown in Table 4.2 for two particle size ranges: less than three microns, and between three and thirty microns. The particle size adjustment factors are from Table 5.1 of the Task B Report.[25]

Table 4.1. RENO SEASONAL EMISSIONS BY SOURCE CATEGORY, TONS

Fugitive Dust Sources	1975				1980				1985			
	Wnt.	Spg.	Sum.	Fall	Wnt.	Spr.	Sum.	Fall	Wnt.	Spg.	Sum.	Fall
Construction	203.3	203.4	203.4	203.4	224.8	224.8	224.8	224.8	252.0	252.0	252.0	252.0
Normal streets	206.9	258.5	310.2	258.5	255.5	319.5	383.4	319.5	304.5	380.7	456.8	380.7
Dirty streets	4.1	5.1	6.2	5.2	4.1	5.1	6.2	5.2	4.1	5.1	6.2	5.2
Unpaved roads	793.8	992.2	1190.7	992.3	793.8	992.2	1190.7	992.3	766.6	958.2	1149.9	958.2
Sand and gravel pits	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	79.0	79.0	79.0	79.0
Agriculture	46.1	37.4	17.3	20.2	46.1	37.4	17.3	20.2	46.1	37.4	17.3	20.2
Street sanding	140.0	-	-	-	140.0	-	-	-	140.0	-	-	-
Various fugitive sources:												
Cleared areas	15.3	12.4	5.7	6.7	15.3	12.4	5.7	6.7	15.3	12.4	5.7	6.7
Heavy equipment storage	1.1	1.1	0.6	0.6	1.1	1.1	0.6	0.6	1.1	1.1	0.6	0.6
Playgrounds	16.6	16.5	8.9	8.9	16.6	16.5	8.9	8.9	16.6	16.5	8.9	8.9
Unpaved parking lots	7.8	9.7	11.6	9.7	7.8	9.7	11.6	9.7	7.8	9.7	11.6	9.7
Road shoulders	0.6	0.7	0.8	0.7	0.6	0.7	0.8	0.7	0.6	0.7	0.8	0.7
Railroad right-of-ways	11.6	11.6	6.2	6.2	11.6	11.6	6.2	6.2	11.6	11.6	6.2	6.2
Fugitive dust totals	1562.2	1663.6	1876.6	1627.4	1632.3	1746.0	1971.2	1709.8	1645.3	1764.4	1995.0	1728.2
Fuel combustion	161.1	68.0	8.7	150.4	180.9	76.3	9.8	168.9	206.0	86.8	11.2	192.3

Table 4.2. RENO PARTICLE SIZE EMISSIONS BY SOURCE CATEGORY, TONS/YEAR

Fugitive dust sources	1975		1980		1985	
	<3μ	3-30μ	<3μ	3-30μ	<3μ	3-30μ
Construction	357.9	455.6	395.6	503.6	443.5	564.5
Normal streets	537.8	496.3	664.5	613.4	791.8	730.9
Dirty streets	10.7	9.9	10.7	9.9	10.7	9.9
Unpaved roads	2063.9	1905.1	2063.9	1905.1	1993.2	1839.8
Sand and gravel pits	262.2	197.8	262.2	197.8	180.1	135.9
Agriculture	59.3	61.7	59.3	61.7	59.3	61.7
Street sanding	72.8	67.2	72.8	67.2	72.8	67.2
Various fugitive sources:						
Cleared areas	27.3	12.8	27.3	12.8	27.3	12.8
Heavy equipment storage	2.3	1.1	2.3	1.1	2.3	1.1
Playgrounds	34.6	16.3	34.6	16.3	34.6	16.3
Unpaved parking lots	20.2	18.6	20.2	18.6	20.2	18.6
Road shoulders	1.5	1.3	1.5	1.3	1.5	1.3
Railroad right-of-ways	24.2	11.4	24.2	11.4	24.2	11.4
Fugitive dust totals	3474.7	3255.1	3639.1	3420.2	3661.5	3471.4

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6. APPENDICES

APPENDIX A

POINT SOURCES IN RENO STUDY AREA

Grid	Plant Name	UTM		TSP, T/yr.		
		E, km	N, km	1975	1980	1985
42	Nevada Aggregate & Asphalt	260.5	4378.7	19	21.9	-
45	Robt. L. Helms Const. Co.	267.0	4378.0	4	4.6	5.2
Total				23	26.5	5.2

APPENDIX B. VARIOUS FUGITIVE DUST SOURCES FOR RENO

(tons/yr)

Grid	Cleared areas	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16				3.4				3.4
17				2.6				2.6
18								
19								
20								
21								
22								
23								
24				0.6				0.6
25								
26								
27								
28								
29								
30								
31				0.6				0.6
32		12.8	3.1			0.3		16.2
33		2.6						2.6
34	8.1	3.9	1.2		0.5			13.7
35								
36								
37		3.8	0.1	1.0		0.2		5.1
38								
39	1.5	10.8		0.2				12.5
40	0.5			0.9				1.4
41	0.9		0.2	2.0				3.1
42		2.1	0.4	0.8	2.2			5.5
43	0.3	2.1	3.0	16.1	0.7			22.2
44				5.3				5.3

APPENDIX B (continued). VARIOUS FUGITIVE DUST SOURCES FOR RENO

(tons/yr)

Grid	Cleared areas	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
45			0.9	1.2				2.1
46	3.2							3.2
47				0.1				0.1
48	3.6	3.9	29.9	0.4		2.3	9.0	49.1
49								
50	1.4							1.4
51	1.6	8.9						10.5
52								
53				0.3				0.3
54				0.1				0.1
55	12.0							12.0
56								
57								
58								
59								
60	7.0							7.0
61								
Total	40.1	50.9	38.8	35.6	3.4	2.8	9.0	180.6

TASK D/E REPORT - EMISSION MODELING AND CONTROL STRATEGY DEVELOPMENT (LAS VEGAS)

1. INTRODUCTION

At the present time the National Ambient Air Quality Standard (NAAQS) for Total Suspended Particulate (TSP) is being exceeded in the Clark-Mohave-Yuma (Las Vegas) Air Quality Control Region (AQCR). Since relatively few uncontrolled point sources and conventional area sources of TSP have been identified in this region, the probability exists that the impact on TSP air quality from fugitive dust sources is causing non-attainment. Therefore, as part of a multiphase effort to resolve this problem, PEDCo-Environmental has assembled and analyzed all available air quality and meteorological data for the base year 1975 in the study areas to better identify the nature of the particulate problem. "Microinventories" of the areas surrounding each sampling location were also conducted to determine specific sources and source categories influencing the measurements at the sites. Additionally, pertinent factors which influence the generation of fugitive TSP in this geographical area were evaluated and defined. Using these factors, an emission inventory of the study area was produced for both the base year (1975) and the projected years of 1980 and 1985. These data have been tabulated in Section 2.0 of this report in a format prescribed for modeling. The model chosen for evaluation of TSP control strategies, the "Hanna-Gifford" relationship, is described in Section 3.0.

Once the data base was assembled, and the model validated for use in this region, meetings were held with local and state agency personnel in order to review potential control measures for the significant TSP source categories. The options chosen for evaluation relative to control of fugitive emissions are defined in Section 5.0.

In order to obtain the most realistic projections of TSP control options on air quality, it was decided to use a "weighing factor" developed during the special project effort devoted to characterization of the airborne particulate in this specific area. Simply stated, this factor was developed in order to account for the disparity observed between the percent mineral composition of hi-volume samples and the percent of mineral emissions detected in the inventory. The development of this factor is discussed in detail in Section 6.0.

Section 7.0 of this report summarizes the results of the control strategy modeling effort. Section 8.0 presents a discussion of both existing and proposed regulatory considerations which directly relate to possible implementation of the control options evaluated.

2. EMISSION INVENTORIES

When evaluating a total suspended particulate (TSP) problem, it is necessary to develop an emission inventory. The emission inventory data presented in this section are the summary tables of the Task C Report.[1] Detailed explanation of the development of the base year and projected emissions inventories is contained in that report. The emission categories, conventional except for several fugitive dust categories which have been included, are as follows:

- Stationary
    - Residential/commercial fuel combustion
    - Industrial fuel combustion
    - Industrial processes
    - Burning
- Mobile
    - Aircraft/railroad
    - Highway vehicles
    - Off-highway vehicles
- Fugitive dust
    - Construction
    - Dust entrainment from paved roads (normal and dirty)
    - Unpaved roads
    - Sand and gravel pits
    - Agriculture
    - Various fugitive dust sources (including - cleared areas, playgrounds, unpaved parking lots, railroad right-of-ways and yards, heavy equipment storage, road shoulders, and horse corrals).

To identify areas of high emission concentrations and apply diffusion modeling techniques, it was necessary to establish a grid network covering the study area and allocate the emission totals throughout the grid system. The grid overlay is shown in Figure 2.1 and the allocation

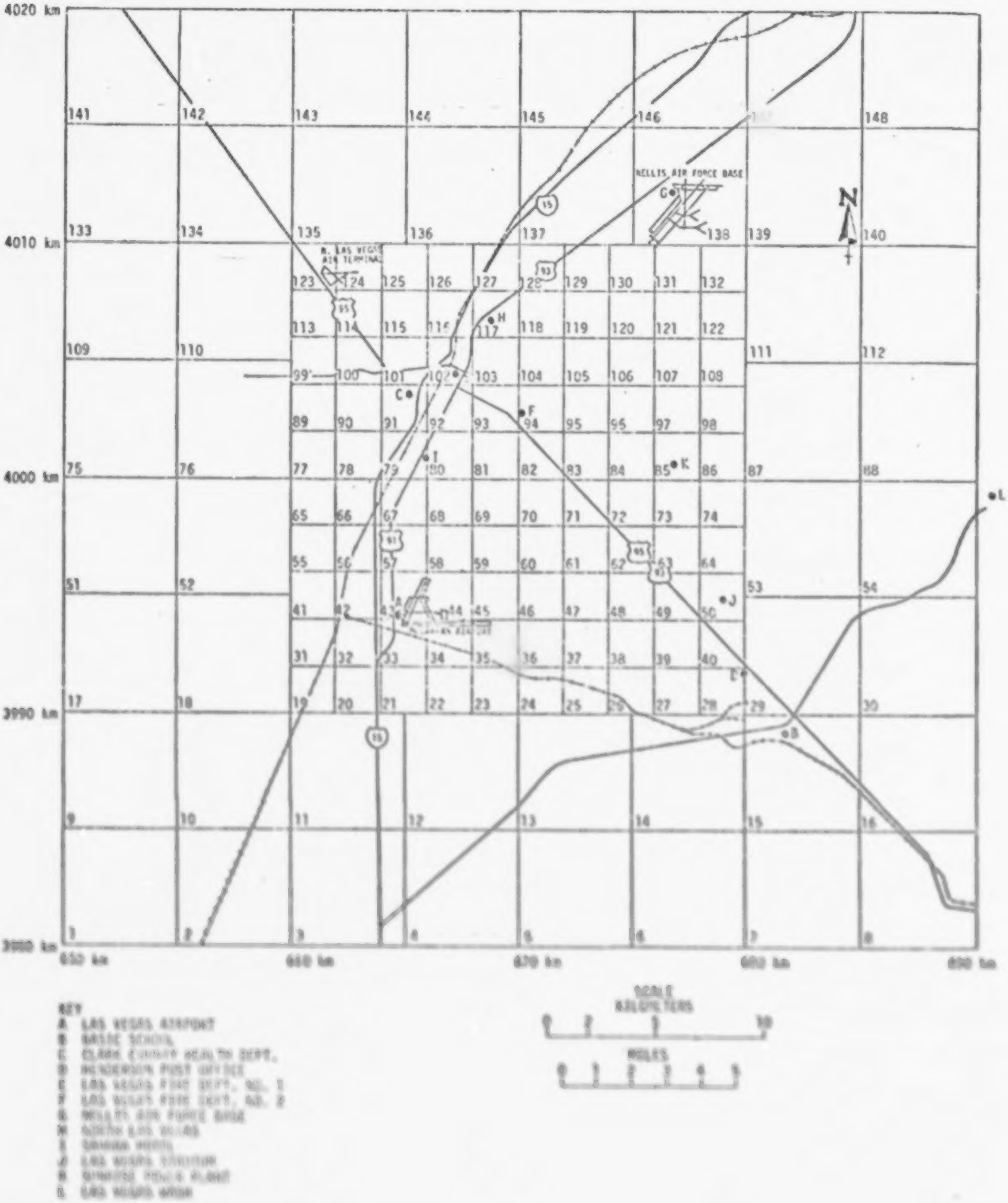
4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
N
N. LAS VEGAS AIR TERMINAL
NELLIS AIR FORCE BASE
15
93
95
KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STATION
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5

Figure 2.1 Las Vegas study area with grid overlay.

procedures explained in the Task C Report.[1] Tables 2.1, 2.2 and 2.3 show emission inventories by source category and by grid for 1975, 1980 and 1985, respectively. Table 2.4 shows the category breakdown of the various fugitive emissions except for cleared areas. Cleared areas is the only various fugitive emission category whose 1975 emissions change for 1980 and 1985. This is because construction activity will decrease the cleared area acreage in several grids. Therefore, emissions for this category are shown in Table 2.5. Various fugitive source total emissions by grid in Tables 2.1, 2.2, and 2.3 is the sum of Tables 2.4 and 2.5. Table 2.6 shows the annual percentage increase in emissions from each source category. These growth factors were used to project 1975 emissions to 1980 and 1985.

A category not included in the emission inventory is dust from natural surfaces. However, emissions from this category were developed and included in the model because of their localized influence. Natural surface emissions were determined to be a variable source whose emission strength is a function of soil type and the amount of natural surface area in each grid. Development of emissions from this source category are explained in the following section.

NATURAL SURFACE EMISSIONS

In an attempt to account for emissions from sources which were not covered in the emission inventory, the source category of natural surfaces was developed.

Emission Factors

As a first appoximation, based on the emission factor for cleared areas (Task B Report,[2] page 2-4), the emission factor for undistured surfaces must be equal to or less than 0.1 ton/acre/y, or 64 ton/mi^2/yr. In order to obtain

Table 2.1. EMISSION SUMMARY BY GRID, LAS VEGAS 1975[a] (ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens. ton/ mi^2/yr
	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.		
1											121				121.0	12.5
2					0.9						121			3.0	124.9	12.9
3					0.8	1.9			5.0		48			2.5	58.2	6.0
4						0.8			2.2		97				100.0	10.4
5																
6																
7									0.1		97				97.1	10.1
8						4.9			13.0					4.1	22.0	2.3
9											218			3.8	221.8	23.0
10					1.1	0.8		4.7	2.2		121			16.3	146.1	[illegible]
11	0.1				0.4	12.6	0.1		33.8					1.2	48.2	5.0
12	0.5			0.1		1.4	0.6	4.6	3.8		218				229.0	23.7
13						2.0		4.8	5.3						12.1	1.3
14					0.1	1.9		5.0	4.9					26.4	38.3	4.0
15	5.0			0.7	0.1	5.6	6.0	12.4	14.9		82			66.9	193.6	20.1
16											193			0.6	193.6	20.0
17											193				193.0	20.0
18						0.2		2.3	0.6		97				100.1	10.4
19					0.6									1.8	2.4	1.6
20						5.3		4.2	14.2						23.7	15.3
21	0.1					1.1	0.1	6.6	2.9						10.8	7.0
22						0.7	0.1	4.5	1.7						7.0	4.5
23						0.4			1.1					0.8	2.3	1.5
24	0.1						0.1	4.3	0.1					1.5	6.1	3.9
25						0.3		4.7	0.9					1.5	7.4	4.8
26						0.2			0.6					0.8	1.6	1.0
27		1.7	135												136.7	88.6
28		8.6	27			5.5			14.7					1.8	57.6	37.3
29	4.0		263	0.6		11.1	4.8	7.6	29.6		186				506.7	52.5
30						0.7			1.9		97				99.6	10.3
31					0.3			4.9	0.1					0.9	6.2	4.0
32					0.2	2.9	0.1	2.0	7.6					2.1	14.9	9.6
33					8.3	0.5		2.4	1.4					5.3	17.9	11.6
34					16.6	1.0		2.4	2.7					1.5	24.2	16.7
35					0.3	1.8		2.3	4.8					0.9	10.1	11.7
36	0.1					1.6	0.2	6.2	4.0						12.1	8.5
37	0.1					1.3	0.1	9.4	3.4						14.3	9.3
38						0.7			1.9						2.6	1.7
39		0.9				0.9			2.5						4.3	2.8
40		3.4	611			10.4		4.9	27.7		17	42		35.9	[illegible]	[illegible]
41																
42	0.1	0.9			0.9	0.9	0.1		1.3					1.9	6.1	[illegible]
43	0.1				[illegible]	[illegible]	0.1	3.0	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
44	1.3			0.2	[illegible]	[illegible]	[illegible]	1.2	[illegible]						[illegible]	[illegible]
45	1.0			0.3		[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]
46	0.6			0.1		1.4	[illegible]	[illegible]	[illegible]					100.0	[illegible]	[illegible]
47	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]
48	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]
49	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]
50						[illegible]			[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
51											[illegible]				[illegible]	[illegible]
52	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
53											[illegible]				[illegible]	[illegible]
54											[illegible]				[illegible]	[illegible]
55	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]

Table 2.1 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1975 [a] (ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens. ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
56	0.2	1.7			0.5	5.6	0.2	0.8	14.9					20.7	44.6	28.9
57	2.5			0.4		17.1	3.0	0.9	37.5	13.6	10			37.8	122.8	79.5
58	2.4			0.4		18.5	3.0	11.5	49.4						85.2	55.2
59	2.3			0.3		11.5	2.8	7.9	30.8					171.0	226.6	146.7
60	0.7			0.1		6.7	0.8	17.8	18.0					171.0	215.1	139.3
61	2.5			0.4		6.5	3.0	11.0	17.4						40.8	26.4
62	3.3			0.5		14.0	4.0	2.7	37.5					144.9	206.9	134.0
63	0.5			0.1		2.4	0.6	5.0	6.5						15.1	9.8
64																
65	0.7			0.1		2.2	0.9	9.9	5.9						19.7	[illegible]
66	1.0	3.4	6	0.1	0.2	8.7	1.2	2.3	23.3		12			0.8	59.0	38.2
67	1.6	1.7		0.2	0.2	31.3	1.9	3.1	83.5					11.5	135.0	87.4
68	5.5			0.8		13.5	6.6	1.7	32.6	5.9				22.9	89.5	58.0
69	1.2			0.2		15.1	1.4	15.2	40.3						73.4	47.5
70	2.2			0.3		3.1	2.7	4.0	8.2					52.2	72.7	47.1
71	3.2			0.5		11.8	3.8	1.4	31.5					59.0	111.2	72.0
72	0.7			0.1		5.8	0.9	7.1	15.6						30.2	19.6
73							0.1						90		90.1	58.3
74																
75											169				169.0	17.8
76	0.7			1.3		7.5	10.4	13.1	20.0		183			62.7	316.7	32.8
77	1.8			0.3		7.9	2.2	21.1	21.0						54.3	35.2
78	2.9	0.9		0.4		9.9	3.5	9.6	26.4					68.9	120.5	78.0
79	1.2	1.7		0.2	1.1	22.6	1.5	4.5	76.5					73.5	188.0	122.2
80	3.1			0.5		33.8	3.7	4.6	75.1	24.4				70.9	216.1	139.9
81	4.1			0.6		23.0	5.0	3.8	61.6						98.1	63.5
82	3.9			0.6		19.8	4.7	11.6	52.9		10			30.9	134.4	87.0
83	2.1			0.3		9.1	2.6	2.6	24.3						41.0	26.5
84	0.7			0.1		4.0	0.8	2.6	10.8						19.0	12.2
85		3.4	871									60	90	7.8	1041.2	674.8
86		1.7	130												131.7	85.3
87											101				101.0	65.5
88											24				24.0	15.6
89	2.8			0.4		12.0	3.4	10.1	32.0						60.7	39.3
90	2.7			0.6		11.4	3.3	3.4	30.5		19			90.0	167.2	108.3
91	2.1	2.6	7	0.3	0.7	30.0	2.5	7.9	42.8		11			153.0	246.7	159.7
92	3.7	1.7		0.6	0.2	45.6	4.5	0.6	121.0		110			80.2	382.7	247.8
93	4.0			0.6		31.9	4.0	2.1	85.2		24			40.3	201.0	130.1
94	2.6			0.4		8.3	3.0	3.4	22.1					48.6	86.1	56.0
95	1.2			0.2		3.6	1.0	30.2	8.1					11.5	61.0	39.5
96	0.5	0.9		0.1		3.0	0.0	0.6	7.0					27.5	45.3	29.3
97		1.7	20			0.2			0.6						84.0	55.0
98																
99	3.0			0.5		10.5	3.8	3.9	30.4						97.0	37.0
100	1.6			0.2		9.8	1.7	2.2	26.3					5.5	67.1	30.5
101	2.3			0.3		13.0	2.0	5.2	30.7		2			1000.0	1100.0	[illegible]
102	3.1	2.0	5	0.5	0.5	35.1	3.0	11.0	80.0			55		65.3	210.3	136.3
103	4.0			0.7		18.9	2.0	1.1	60.0		70			64.1	200.2	133.7
104	2.5			0.6		6.9	3.1	10.0	51.0					10.0	66.1	61.0
105	1.6			0.4		3.6	1.0	2.0	6.2						50.7	50.0
106	0.7			0.1		3.7	0.0	2.2	8.0					60.7	30.1	65.0
107						0.6			0.9						0.0	0.0
108	1.3						0.0	1.1							0.0	1.2
109											40				40.0	0.0
110	0.0			0.7		1.0	0.0	10.0	0.0		200			100.0	401.7	90.0

Table 2.1 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1975[a]
(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens. ton/mi^2/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
111						0.1			0.4		169				169.5	17.6
112											97				97.0	10.0
113	2.7			0.4		4.8	3.2	6.7	12.9						30.7	19.9
114	2.1			0.3		1.9	2.5	10.5	5.0						22.3	14.4
115	4.5			0.7		4.0	5.4	2.5	10.8						27.9	18.1
116	4.6	1.7		0.7	0.5	7.1	5.5	11.6	18.9		22			8.1	80.7	52.3
117	5.3			0.8		19.1	6.4	4.0	50.9					75.1	161.6	104.6
118	3.9			0.6		12.9	4.8	13.1	34.3						69.6	45.1
119	1.2			0.2		4.1	1.5	21.9	11.0						39.9	25.8
120	0.7			0.1		4.3	0.9	17.4	11.6						35.0	22.7
121				0.1		2.0		2.5	5.4						10.0	6.5
122						0.3			0.7						1.0	0.6
123	0.8			0.1	0.7	7.3	0.9	4.4	19.4						33.6	21.8
124	0.8			1.0	1.4	0.4	1.0	1.6	1.1						7.3	4.7
125	2.4			1.3		1.2	2.9	1.8	3.3		5			45.1	63.0	40.8
126	1.8	0.9		1.2		0.7	2.1	1.4	1.9						10.0	6.5
127	5.6	1.7		0.8	0.4	8.3	6.7	8.2	22.2					1.2	55.1	35.7
128	3.2			0.5		5.9	3.0	1.4	15.6						30.4	19.7
129	0.9			0.1		4.1	1.1	0.4	10.9						17.5	11.3
130	0.4			0.1		4.8	2.4	0.3	2.3						10.3	6.7
131	0.6			0.1			0.7	16.4							17.8	11.5
132																
133											290				290.0	30.0
134	0.8			1.9		5.7	0.9	6.9	14.9		242				273.1	28.3
135	0.2			6.3		1.9	0.3	7.5	5.0						21.2	2.2
136	0.6			3.7	0.6	1.2	0.7	8.6	3.3					1.8	20.5	2.1
137	3.3	0.9		0.5	1.0	14.0	4.0	5.0	37.5					3.2	69.4	7.2
138	2.4	1.7		0.4	11.6	8.3	2.5	2.0	16.2			1		20.4	66.5	6.4
139																
140																
141	0.2					2.7	0.5		7.3		97				107.7	11.1
142	0.1					1.5	0.3	8.8	5.0		304				319.7	31.2
143				0.2					0.1						0.3	0.0
144				3.0							121				124.0	12.8
145			9		0.9						79			2.3	91.2	9.0
146	0.4		10	0.1	1.4	2.7	0.5	8.8	7.2		145			4.4	180.5	18.7
147					0.3	0.9			2.5		73			1.0	77.7	8.0
148											73				73.0	7.6
Tot.	171.6	55.8	1968.2	81.9	86.3	795.7	196.6	471.6	2120.7	61.0	8816.2	711.8	186.3	2641.2	18685.1	

[a] Natural surface emissions, while part of the inventory, are not included. See Table 2.8.

Table 2.2, EMISSION SUMMARY BY GRID, LAS VEGAS 1980[a,b]

(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens, ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
1											121				121.0	12.5
2					1.1						121			3.0	125.1	13.0
3					1.0	2.0			7.4		48			2.5	60.9	6.4
4						1.5			5.5		97				104.0	10.9
5																
6																
7						0.4			1.7		97				99.1	10.4
8						3.6			13.3					4.1	21.0	2.2
9											218			3.0	221.0	23.0
10	0.2				1.4	0.6	0.3	5.4	2.2		121			16.3	147.4	15.3
11					0.5	13.8			50.5					1.2	66.0	6.9
12	0.7			0.1		1.9	0.8	5.3	7.1		218				233.9	24.2
13	0.2					3.5	0.3	5.5	13.0						22.5	2.3
14	0.2				0.1	2.1	0.3	5.7	7.9					26.4	42.7	4.4
15	5.4			0.8	0.1	12.3	6.6	14.1	44.9		82			66.9	233.1	24.1
16						1.0			3.6		193			0.6	198.2	20.5
17											193				193.0	20.0
18	0.1					0.7	0.1	2.6	2.5		97				103.0	10.7
19														1.8	1.8	1.2
20	0.2				0.7	4.2	0.3	5.3	15.5						26.2	17.0
21	0.4					1.7	0.4	7.5	6.2						16.2	10.5
22	0.2					1.8	0.3	5.5	6.7						14.5	9.4
23						1.4			5.4					0.8	7.6	4.9
24	0.2					1.1	0.3	4.9	4.2					1.5	12.2	7.9
25	0.2					0.7	0.3	5.3	2.8					1.5	10.8	7.0
26						1.0			3.6					0.8	5.4	3.5
27		1.9	169			0.9			3.4						175.2	100.5
28		9.5	30			5.7			21.4					1.8	68.4	44.3
29	4.3		290	0.7		9.9	5.2	8.6	37.1		186				541.9	56.1
30						0.7			2.5		97				100.2	10.4
31	0.2				0.4	0.2	0.3	5.6	0.7					0.9	8.3	5.4
32	0.1				0.2	4.3	0.2	2.3	16.1					3.1	26.3	14.4
33	0.1				9.4	1.3	0.1	2.7	5.0					5.3	23.9	15.6
34	0.1				18.8	2.3	0.1	2.7	8.4					1.5	33.9	22.0
35	0.1				9.4	2.3	0.1	2.6	12.3					0.9	27.7	18.6
36	0.4					3.5	0.5	7.0	13.2						24.6	15.9
37	0.4					2.8	0.1	10.7	10.4						24.8	16.1
38						1.8			6.7						8.5	9.6
39		0.1				1.7			6.2						8.0	5.7
40	0.2	3.0	494			10.8	0.3	5.5	20.3		17	42		21.9	615.0	391.0
41						0.1			0.4						0.5	0.3
42		9.5			0.6	1.0			2.6					1.7	15.4	10.6
43	0.3				18.0	10.5	0.1	4.3	30.2		121			23.1	208.0	172.6
44	1.1			0.2	9.4	8.8	1.4	1.4	30.7						53.0	35.6
45	2.2			0.1		3.2	2.6	8.8	11.8						28.5	18.8
46	0.6			0.1		2.4	0.8	6.2	6.8					140.0	157.0	108.7
47	0.6					2.9	1.0	13.2	8.3						26.0	17.4
48	0.8		144	0.1		1.8	1.0	2.1	6.8						156.6	101.6
49	0.8			0.1		8.0	1.0	3.1	30.8						47.0	31.0
50						0.6			2.1		16	60		8.6	86.0	55.6
51						0.1			0.4		263				263.0	20.2
52	2.3	95.0	1020	0.6		0.2	0.5	3.0	10.1		300	320		161.0	2070.0	214.7
53						0.6			10.6		278				237.0	28.8
54											10				10.0	0.8
55	0.7			0.1		0.7	0.0	0.0	10.1					41.0	50.0	28.9

Table 2.2 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1980 [a,b] (ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens. ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail/air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
56	0.2	1.9			0.6	8.7	0.2	2.0	32.6					20.7	66.9	43.3
57	2.5			0.4		17.9	3.1	1.1	66.0		10			30.3	131.3	85.0
58	2.9			0.4		13.2	3.5	13.1	48.4						81.5	52.8
59	2.6			0.4		9.6	3.2	9.0	35.7					136.8	197.3	127.8
60	1.4			0.1		6.6	1.7	20.2	24.5					136.8	191.3	123.9
61	2.9			0.4		6.0	3.6	12.5	22.6						48.0	31.1
62	3.4			0.6		13.9	4.1	3.1	50.8					144.9	220.8	143.0
63	0.7			0.1		4.4	0.8	5.7	16.5						28.2	18.3
64						2.5			9.2						11.7	7.6
65	1.1			0.1		4.8	1.4	11.3	17.9						36.6	23.7
66	1.0	3.8	7	0.2	0.2	13.7	1.3	2.6	50.1		12			0.8	92.7	60.0
67	1.7	1.9		0.3	0.2	23.6	2.1	3.5	87.2					9.4	129.9	84.1
68	5.5			0.9		9.7	6.7	2.0	36.2					18.3	79.3	51.3
69	1.8			0.2		10.9	2.2	17.4	39.8						72.3	46.8
70	2.4			0.4		5.0	2.9	4.5	18.6					41.8	75.6	49.0
71	3.2			0.5		12.1	3.9	1.6	44.3					59.0	124.6	80.7
72	1.0			0.1		7.5	1.3	8.1	28.2						46.3	30.0
73						1.5			5.7				90		97.2	63.0
74																
75						0.1			0.5		169				169.6	17.6
76	9.1			1.5		15.3	11.1	14.9	56.1		193			62.7	363.7	27.7
77	2.6			0.3		8.2	3.2	23.9	12.5						50.7	32.8
78	3.2	0.9		0.5		9.0	3.9	10.9	33.4					66.9	128.7	83.3
79	1.4	1.9		0.2	1.4	28.6	1.7	5.1	90.4					63.0	193.7	125.3
80	3.3			0.5		25.9	4.0	5.2	95.8					56.7	191.4	123.9
81	4.2			0.7		19.7	5.2	4.4	72.7						106.9	69.2
82	3.9			0.7		17.0	4.7	10.0	62.5		10			24.7	133.5	86.4
83	2.2			0.4		11.7	2.7	2.9	42.8						62.7	40.6
84	0.8			0.1		4.0	1.0	3.0	15.1						24.0	15.5
85		3.8	962			1.3			6.0			60	90	7.8	1130.9	737.6
86		1.9	144												145.9	94.5
87											121				121.0	12.5
88											20				20.0	2.5
89	3.2			0.5		13.0	3.9	11.5	47.5						79.6	51.5
90	2.9			0.5		11.5	3.5	3.0	42.1		10			94.6	168.1	[illegible]
91	2.4	2.0	8	0.4	0.9	15.4	2.9	0.0	50.4		11			125.2	236.4	153.0
92	3.7	1.9		0.6	0.2	60.1	4.5	0.5	160.6		110			68.2	430.3	281.0
93	6.1			0.7		23.7	5.0	2.3	110.1		20			36.6	214.5	139.0
94	2.8			0.4		13.1	3.2	3.9	67.0					26.1	107.1	69.3
95	2.8			0.2		6.7	3.1	20.0	25.2					11.5	88.3	57.2
96	0.7	0.9		0.1		0.9	0.8	5.5	18.4					27.5	58.8	38.1
97		1.0	20			1.0			3.0						41.7	27.0
98						0.5			1.9						2.4	1.6
99	[illegible]			0.5		[illegible]	4.0	6.4	67.1						97.5	63.1
100	1.5			0.2		13.8	1.0	0.5	[illegible]					5.9	[illegible]	[illegible]
101	2.4			0.6		[illegible]	[illegible]	[illegible]	[illegible]		7			[illegible]	[illegible]	[illegible]
102	3.6	[illegible]	6	0.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]
103	[illegible]			[illegible]		[illegible]	[illegible]	1.2	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
104	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]
105	1.8			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]
106	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]
107						[illegible]			[illegible]						[illegible]	[illegible]
108	[illegible]					[illegible]	[illegible]	1.0	[illegible]						[illegible]	[illegible]
109											[illegible]				[illegible]	[illegible]
110	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
111						[illegible]			[illegible]		[illegible]				[illegible]	[illegible]

Table 2.2 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1980[a,b]

(ton/yr)

	Stationary				Mobile			Fugitive dust								
Grid	Res/ comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Var. fugit. sourc.	Total ton/yr	Emiss. dens. ton/ mi²/yr
112											97				97.0	10.0
113	2.9			0.5		7.3	3.6	7.6	27.3						49.2	31.9
114	2.5			0.4		8.8	3.0	11.9	32.9						59.5	30.5
115	4.5			0.8		6.7	5.5	2.9	24.9						45.3	29.3
116	5.0	1.9		0.8	0.6	9.1	6.1	13.2	38.1		22			0.1	100.9	65.3
117	5.4			0.9		17.4	6.6	4.5	63.9					76.1	173.0	112.5
118	4.5			0.7		12.0	5.4	15.0	44.0						81.6	92.0
119	2.1			0.2		4.2	2.6	25.0	15.6						49.7	32.2
120	1.4			0.1		4.7	1.7	19.0	17.6						45.3	29.3
121	0.1			0.1		2.1	0.1	2.0	7.8						13.0	8.4
122						1.0			3.6						4.6	3.0
123	0.9			0.1	0.8	8.1	1.1	5.0	33.3						49.3	30.0
124	0.9			1.0	1.6	1.5	1.0	1.8	5.5						13.3	8.6
125	2.5			0.4		4.5	3.0	2.0	16.9		5			45.1	79.4	51.4
126	1.8	0.9		1.2		2.0	2.2	1.6	7.6						17.3	11.2
127	5.6	1.9		1.0	0.5	12.2	7.2	9.3	44.7					1.2	83.6	54.1
128	3.2			0.5		5.4	3.9	1.6	20.3						34.9	22.6
129	0.9			0.2		4.3	1.1	0.5	16.0						23.0	14.9
130	0.6			0.1		1.7	0.7	7.1	6.4						16.6	10.7
131	1.2			0.1		0.7	1.5	16.7	2.5						24.2	15.7
132																
133											290				240.0	30.0
134	1.0			1.9		24.6	1.3	7.8	90.9		242				314.5	30.3
135	0.5			6.3		10.5	0.7	8.6	30.0						64.5	6.7
136	1.0			3.7	0.7	0.9	1.2	0.8	3.4					1.0	27.5	2.3
137	3.5	0.9		0.6	1.2	21.1	4.2	5.7	27.9					3.2	110.3	12.3
138	2.5	1.9		0.6	0.0	5.2	3.0	2.3	10.3			1		20.4	65.2	6.8
139																
140																
141						0.3			23.6		97				526.0	13.2
142	0.5					10.7	0.6	10.0	20.1		216				270.0	50.0
143				8.2		2.1			7.8						56.1	1.9
144				3.6							325				570.0	12.9
145			50		1.1						50			2.3	80.0	8.8
146	0.4		20	0.1	1.7	2.6	0.5	0.9	6.1		565			6.0	121.7	10.9
147					0.6	2.8			13.6		25			5.0	90.8	9.6
148											25				25.0	7.6
Sum	[illegible]	[illegible]	[illegible]	55.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

[a] Natural surface emissions, while part of the inventory, are not included. See Table 2.8.

[b] Present emissions are based on existing process. They do not include reductions attributable to control strategies described in Section 7.0.

Table 2.3. EMISSION SUMMARY BY GRID, LAS VEGAS 1985[a,b]
(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens. ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail/air	Auto exh.	Off hwy veh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
1											121				121.0	12.6
2					1.3						121			3.0	125.3	13.0
3					1.2	2.1			9.8		48			2.5	63.6	6.6
4						1.0			8.9		97				107.0	11.2
5																
6																
7						0.7			3.2		97				100.9	10.5
8						2.9			13.5					4.1	20.5	2.1
9											218			3.8	221.8	23.0
10	0.5				1.6	0.5	0.6	6.2	2.2		121			16.3	148.9	15.4
11					0.6	14.8			69.1					1.2	85.7	8.9
12	0.9			0.1		2.2	1.1	6.1	10.5		218				238.9	24.8
13	0.5					4.4	0.6	6.3	20.7						32.5	3.4
14	0.5				0.1	2.3	0.6	6.6	10.8					26.4	47.3	4.9
15	0.1			1.0	0.1	10.4	2.4	16.2	78.7		82			86.9	267.8	27.7
16						1.6			7.3		193			0.6	202.5	21.0
17											193				193.0	20.0
18	0.2					1.0	0.3	3.0	4.4		97				105.9	11.0
19					0.9									1.8	2.7	1.7
20	0.5					3.8	0.6	6.1	16.9						27.9	17.9
21	0.2					3.0	0.9	8.1	9.5						21.7	16.1
22	0.5					2.5	0.6	5.9	11.7						21.2	15.7
23						2.1			9.6					0.8	12.5	8.1
24	0.5					1.8	0.6	5.6	8.3					1.5	18.3	11.8
25	0.5					3.0	0.6	4.1	4.7					1.5	14.4	9.3
26						1.6			6.6					0.8	9.0	5.7
27		2.1	165			1.5			6.8						175.4	113.6
28		10.5	30			6.0			25.0					1.8	73.3	51.4
29	4.7		321	0.8		10.8	5.7	9.9	76.0		186				615.0	64.0
30						0.6			3.0		97				100.6	10.4
31	0.5				0.4	1.3	0.6	6.4	1.4					0.9	11.5	6.0
32	0.2				0.3	1.5	0.5	2.7	24.7					2.1	32.0	23.1
33	0.2				10.8	1.8	0.3	3.1	8.0					5.3	29.5	19.6
34	0.2				25.1	1.9	0.3	2.2	14.1					1.5	45.3	28.2
35	0.2				10.6	1.2	0.3	3.0	14.0					0.9	30.2	20.3
36	0.7					1.6	0.9	8.1	21.5						32.8	23.2
37	0.8					1.7	1.1	12.3	17.4						33.3	27.9
38						1.4			11.4						12.8	8.8
39		5.3				1.5			9.9						16.7	8.5
40	0.5	6.2	303			1.3	0.8	6.6	32.0		17	62		33.0	462.4	432.4
41						1.2			3.8						5.0	0.7
42		5.0			0.7	1.0			8.0					5.7	20.4	7.8
43	0.5				21.6	1.2	0.8	6.9	33.8		121			73.1	258.9	107.3
44	1.2			0.2	10.6	1.4	1.6	1.6	26.9						43.5	41.1
45	2.9			0.8		1.0	0.1	50.1	37.7						92.6	20.4
46	0.9			0.1		1.0	1.1	7.1	10.0					160.0	180.2	113.6
47	1.6					1.3	1.7	10.2	15.5						[illegible]	[illegible]
48	0.6		160	0.2		1.2	1.6	2.6	50.1						[illegible]	[illegible]
49	0.5			0.1		1.4	1.6	5.6	43.8						[illegible]	28.3
50						1.5			2.3		15	50		5.0	73.8	[illegible]
51						1.2			0.8		303				[illegible]	37.7
52	0.5	15.0	[illegible]	0.6		1.0	6.0	6.1	26.2		322	638		561.2	[illegible]	[illegible]
53						1.5			21.2		210				232.7	25.3
54											73				73.0	7.6
55	0.5			0.1		1.0	1.6	6.6	37.7					65.0	[illegible]	[illegible]
56	0.6	0.6			0.7	1.7	0.3	1.3	50.1					20.7	[illegible]	[illegible]

Table 2.3 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1985[a,b]
(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens., ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail/air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
57	2.6			0.5		16.9		1.2	88.2		10			22.8	144.2	93.4
58	3.5			0.5		10.6	3.1	15.1	49.4						82.2	53.2
59	3.0			0.5		8.4	3.7	10.4	39.0					102.6	167.6	108.5
60	2.3			0.1		6.6	2.9	22.3	31.0					102.6	167.8	108.7
61	3.5			0.5		6.0	4.3	14.4	27.8						56.5	36.6
62	3.5			0.6		14.2	4.3	3.5	66.3					144.9	237.3	153.7
63	0.9			0.1		5.7	1.4	6.5	26.6						41.2	26.7
64						3.9			18.4						22.3	14.4
65	1.6			0.1		6.4	2.0	13.0	29.9						53.0	34.3
66	1.2	4.2	7	0.2	0.3	16.9	1.4	3.0	78.9		12			0.8	125.9	81.5
67	1.9	2.1		0.3	0.3	19.9	2.3	4.0	92.8					7.2	130.8	84.7
68	5.6			1.1		7.8	6.8	2.3	36.2					13.8	73.6	47.7
69	2.6			0.2		8.8	3.1	19.0	41.1						74.8	48.4
70	2.6			0.4		6.2	3.1	5.2	28.1					31.3	77.9	50.4
71	3.3			0.6		12.7	4.0	1.8	38.2					59.0	140.6	91.0
72	1.4			0.1		8.7	1.7	9.3	40.8						62.1	40.2
73						2.5			11.4				90		103.9	67.3
74																
75						0.2			0.9		169				170.1	17.6
76	9.0			1.7		20.2	12.0	17.2	94.2		193			62.7	410.8	42.6
77	3.7			0.3		8.6	4.6	26.1	40.0						83.3	53.9
78	3.7	1.1		0.6		8.7	4.6	12.6	72.3					66.9	170.5	110.4
79	1.6	2.1		0.2	1.6	26.7	2.0	5.9	122.3					52.5	214.6	138.2
80	3.5			0.6		22.1	4.3	6.0	103.3					46.5	182.4	118.0
81	4.4			0.8		18.4	5.4	5.0	85.9						119.9	77.6
82	3.9			0.8		15.9	4.7	8.0	74.2		10			18.5	136.0	88.1
83	2.3			0.4		13.5	2.9	3.3	63.0						85.4	55.3
84	0.9			0.1		4.2	1.1	3.4	18.6						29.3	19.0
85		4.2	1067			2.1			10.0			60	90	7.8	1245.1	806.2
86		2.1	158												160.1	103.7
87											171				171.0	32.8
88											26				26.0	3.9
89	3.7			0.6		13.9	4.6	13.3	64.9						101.0	65.4
90	[illegible]			0.5		11.0	3.7	4.4	55.7		10			96.8	184.8	120.1
91	2.8	3.1	9	0.4	1.0	15.4	3.4	10.4	71.9		11			96.9	225.0	145.7
92	3.7	2.1		0.7	0.3	30.2	4.6	8.5	128.5		116			85.2	412.8	280.2
93	4.2			0.8		29.4	5.1	2.7	137.0		26			29.0	232.2	150.3
94	2.8			0.5		16.2	3.6	4.5	75.5					27.8	130.7	84.6
95	1.8			0.2		8.9	2.2	40.4	41.3					11.5	107.2	69.5
96	0.9	1.1		0.1		6.2	1.1	6.3	28.7					27.5	71.8	46.4
97		2.1	39			3.5			7.8						49.8	32.1
98						0.8			5.9						6.7	4.3
99	3.5			0.6		22.0	4.3	5.0	102.6						138.0	89.4
100	1.6			0.3		16.5	2.0	2.8	99.2					5.5	127.9	82.8
101	2.6			0.4		24.2	3.1	4.1	112.8		2			62.8	209.1	135.4
102	6.2	3.1	6	0.4	0.7	43.1	5.1	15.3	203.0			11		42.0	334.5	216.6
103	4.9			0.8		17.6	6.0	7.6	82.3		82			57.3	258.5	166.0
104	4.2			0.5		9.0	5.1	22.6	42.2					9.8	93.3	60.4
105	2.3			0.3		5.2	2.0	10.3	26.2						46.2	29.9
106	0.8			0.1		5.0	1.1	2.9	26.7					62.7	97.5	66.6
107						2.0			9.2						11.2	7.3
108	0.2					1.2	0.3	1.6	5.5						8.8	5.6
109											60				60.0	5.0
110	0.8			0.8		25.1	6.0	16.3	115.1		260			105.0	529.1	50.0
111						8.8			8.8		160				176.1	17.6
112											97				97.0	10.0

Table 2.3 (continued). EMISSION SUMMARY BY GRID, LAS VEGAS 1985[a,b]
(ton/yr)

Grid	Stationary				Mobile			Fugitive dust							Total ton/yr	Emiss. dens., ton/mi²/yr
	Res/comm. fuel	Ind. fuel	Ind. proc.	Burning	Rail/air	Auto exh.	Off hwy exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/grav.	Agric.	Var. fugit. sourc.		
113	3.3			0.5		9.0	4.0	8.7	41.8						67.3	43.6
114	3.0			0.4		13.0	3.7	13.8	60.7						94.6	61.3
115	4.7			0.9		8.3	5.7	3.3	38.9						61.8	40.0
116	5.6	2.1		0.9	0.7	10.5	6.8	15.2	49.2		22			8.1	120.9	78.3
117	5.6			1.0		16.9	6.8	5.2	78.8					75.1	189.4	122.6
118	5.1			0.8		12.0	6.3	17.2	55.8						97.2	62.9
119	3.3			0.2		4.4	4.0	27.3	30.3						69.5	30.8
120	2.3			0.1		5.0	2.9	21.8	23.5						55.6	36.0
121	0.2			0.1		2.2	0.3	3.2	10.3						16.3	10.6
122						1.4			6.6						8.0	5.2
123	1.2			0.2	0.9	8.0	1.4	5.8	41.1						58.4	38.5
124	0.9			1.1	1.9	2.1	1.1	2.1	10.0						19.2	12.4
125	2.6			1.4		6.5	3.1	2.3	30.5		5			45.1	96.5	62.5
126	1.9	1.1		1.2		2.9	2.3	1.8	13.4						24.6	15.9
127	6.3	2.1		1.1	0.6	14.0	7.7	10.7	69.3					1.2	113.0	73.7
128	3.3			0.6		5.4	4.0	1.9	20.0						39.9	25.8
129	0.9			0.2		4.5	1.1	0.5	21.0						28.2	18.1
130	0.9			0.1		2.3	1.1	0.2	10.6						15.2	10.0
131	2.1			0.1		1.1	2.6	23.6	5.5						35.0	20.4
132																
133											290				290.0	30.0
134	1.4			2.0		36.1	1.7	9.0	168.7		242				460.9	47.7
135	0.9			6.3		15.0	1.1	9.8	73.0						106.7	11.1
136	1.4			3.7	0.9	8.0	1.7	11.3	30.0					1.8	57.6	6.0
137	3.7	1.1		0.6	1.6	25.8	4.6	6.5	120.4					3.2	167.3	17.3
138	2.6	2.1		0.5	9.9	5.2	3.1	2.6	24.3			1		20.4	71.6	7.4
139																
140																
141						8.6			39.9		97				145.5	15.1
142	0.9					16.1	1.1	11.5	75.1		314				418.7	43.4
143				0.2		7.5			19.4						27.1	2.8
144				3.6							121				124.6	12.9
145			11		1.3						73			2.3	87.6	9.1
146	0.5		22	0.1	2.0	3.9	0.6	1.0	8.0		140			4.4	184.2	12.7
147					0.4	2.8			26.7		70			1.9	101.8	10.5
148											70				70.0	7.6
Tot.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

[a] Natural surface emissions, while part of the inventory, are not included. See Table 2.6.

[b] Present emissions are based on existing programs. They do not include reductions attributable to control strategies described in Section 7.0.

Table 2.4 VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-85
(tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral
1						
2			3.0			
3			2.5			
4						
5						
6						
7						
8			4.1			
9			3.0			
10			16.3			
11			1.2			
12						
13						
14		1.3	5.9			
15	5.0	0.4	5.2			
16			0.6			
17						
18						
19			1.0			
20						
21						
22						
23			0.8			
24			1.5			
25			1.5			
26			0.8			
27						
28		0.7	1.1			
29						
30						
31			0.9			
32			2.1			
33			1.0			
34			1.5			
35			0.9			
36						
37						
38						
39						
40		2.0		10.7		
41						
42			1.7			
43		0.6				
44						

Table 2.4 (continued). VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-85 (tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral
45						
46						
47						
48						
49						
50		9.6				
51						
52						
53						
54						
55						
56			1.7			
57		0.2				
58						
59						
60						
61						
62						39.0
63						
64						
65						
66			0.8			
67			0.8			
68		0.1				
69						
70						
71						
72						
73						
74						
75						
76						
77						
78						
79		10.9	3.0	7.1		
80						
81						
82						
83						
84						
85		0.4				
86						
87						
88						

Table 2.4 (continued). VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-85 (tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral
89						
90						
91		4.7	6.1			
92		1.5	86.7			
93						
94		3.0				
95						
96						
97						
98						
99						
100						
101			1.0	5.0		
102		0.9	34.4	4.8		
103						12.0
104						
105						
106						
107						
108						
109						
110						
111						
112						
113						
114						
115						
116			1.5			
117		2.1				
118						
119						
120						
121						
122						
123						
124						
125						
126						
127			1.2			
128						
129						
130						
131						
132						

Table 2.4 (continued). VARIOUS FUGITIVE DUST SOURCES FOR LAS VEGAS EXCEPT CLEARED AREAS - CONSTANT FOR THE PERIOD 1975-85 (tons/yr)

Grid	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral
133						
134						
135						
136			1.8			
137			3.2			
138		0.1				
139						
140						
141						
142						
143						
144						
145			2.3			
146			4.4			
147			1.0			
148						
Total	5.0	38.5	208.9	27.6	0[a]	51.0

[a] Emissions included with unpaved parking lots.

Table 2.5. LAS VEGAS CLEARED AREA EMISSIONS (ton/yr)

Grid	1975	1980	1985
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14	19.2	19.2	19.2
15	56.3	56.3	56.3
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33	3.5	3.5	3.5
34			
35			
36			
37			
38			
39			
40	19.2	19.2	19.2
41			

Table 2.5 (continued), LAS VEGAS CLEARED AREA EMISSIONS (ton/yr)

Grid	1975	1980	1985
42			
43	72.5	72.5	72.5
44			
45			
46	149.0	149.0	149.0
47			
48			
49			
50			
51			
52	161.0	161.0	161.0
53			
54			
55	41.0	41.0	41.0
56	19.0	19.0	19.0
57	37.6	30.1	22.6
58			
59	171.0	136.8	102.6
60	171.0	136.8	102.6
61			
62	105.9	105.9	105.9
63			
64			
65			
66			
67	10.7	8.6	6.4
68	22.8	18.2	13.7
69			
70	52.2	41.8	31.3
71	59.0	59.0	59.0
72			
73			
74			
75			
76	62.7	62.7	62.7
77			
78	66.9	66.9	66.9
79	52.5	42.0	31.5
80	70.9	56.7	42.5
81			

Table 2.5 (continued). LAS VEGAS CLEARED AREA EMISSIONS
(ton/yr)

Grid	1975	1980	1985
82	30.9	24.7	18.5
83			
84			
85	7.4	7.4	7.4
86			
87			
88			
89			
90	96.6	96.6	96.6
91	143.0	114.4	85.8
92			
93	48.3	38.6	29.0
94	41.4	33.1	24.8
95	11.5	11.5	11.5
96	27.5	27.5	27.5
97			
98			
99			
100	5.5	5.5	5.5
101	94.6	75.7	56.8
102	3.2	2.6	1.9
103	42.1	33.7	25.3
104	16.3	13.0	9.8
105			
106	52.7	52.7	52.7
107			
108			
109			
110	120.0	120.0	120.0
111			
112			
113			
114			
115			
116	6.6	6.6	6.6
117	73.0	73.0	73.0
118			
119			
120			
121			
122			

Table 2.5 (continued). LAS VEGAS CLEARED AREA EMISSIONS (ton/yr)

Grid	1975	1980	1985
123			
124			
125	45.1	45.1	45.1
126			
127			
128			
129			
130			
131			
132			
133			
134			
135			
136			
137			
138	20.3	20.3	20.3
139			
140			
141			
142			
143			
144			
145			
146			
147			
148			
Total	2,309.9	2,108.2	1,906.5

Table 2.6. SOURCE CATEGORY GROWTH FACTORS FOR LAS VEGAS

Category	Annual growth factor, %		Type of growth	Basis for factor
	1975-1980	1975-1985		
Stationary sources				
Fuel combustion				
Residential	1.7	2.3	simple	dwelling units using each fuel type
Comercial/institutional	2.7	2.7	compound	population increase
Industrial	2.0	2.0	compound	CCDHD estimate
Industrial processes	2.0	2.0	compound	CCDHD estimate
Burning				
Wild fire	0	0	no change	
Structural	2.7	2.7	compound	population increase
Mobile sources				
Aircraft	1.7	1.9	compound	LTO increases at each airport
Railroad	5.0	4.4	simple	rail activity
Highway				
Heavy-duty gas/diesel	0	0	no charge	
Light-duty gas	13.3[a]	13.3[a]	simple	VMT increase
Off-highway	2.7	2.7	compound	population increase
Fugitive dust sources				
Construction	2.7	2.7	compound	population increase
Normal paved streets	13.3	13.3	simple	VMT increase
Dirty paved streets	-	-	eliminated	observed to be normal
Unpaved roads	0	0	no change	
Sand and gravel pits	0	0	no change	
Agriculture	0	0	no change	
Various fugitive sources	0	0	no change	except cleared areas
Cleared areas	-4.0	-4.0	simple	land development in specific grids only

[a] Although VMT increased at this rate, the emission factors for light-duty vehicles are expected to decrease due to the continued use of unleaded fuel.

a better estimate of what this value might be, several methods were used.

The average background in the Las Vegas study area is 35 $\mu g/m^3$ (annual geometric mean).[3] Approximately 5 $\mu g/m^3$ can be accounted for from sulfates and condensable organics. Some of the sulfates could be mineral in origin rather than from the atmospheric conversion of SO_2. Assuming that the aerosol portion of airborne sulfates is uniform throughout the study area, the lowest sulfate concentration measured in the network should provide a reasonable estimate of this aerosol portion. Table 2.7 shows this value to be 2.5 $\mu g/m^3$.

Some organic material in the fugitive dust could also be measured in the benzene soluble fraction, as opposed to the condensed organics in the atmosphere. Therefore, the lowest concentration is again used as the rationale for selecting the aerosol portion of the organics. A concentration of 2.5 $\mu g/m^3$ from Las Vegas Wash was used rather than the 2.2 $\mu g/m^3$ value from Basic School, because the Las Vegas Wash station is a "background" site.

Another 5 $\mu g/m^3$ can be assumed to be from long range transport. Thus, the local influence is approximately 25 $\mu g/m^3$. From a curve of emission density vs. air quality, shown in the Task A Report,[4] a 25 $\mu g/m^3$ increment of particulate concentration corresponds to an emission density of 50 tons/mi^2/year.

Another method used to determine emission density is dispersion modeling. The basic equation for ground level emissions is

$$\chi = Q/\pi\ \sigma_y\ \sigma z\ u$$

where

χ = concentration due to local influence, 25 $\mu g/m^3$
Q = source strength, g/sec
u = wind speed, m/sec
σ_y = standard deviation of dispersion in y direction, m
σ_z = standard deviation of dispersion in z direction, m

Table 2.7. 1973 LAS VEGAS SAMPLING DATA FOR SULFATES AND BENZENE SOLUBLES IN μg/m^3

Site	Sulfates	Benzene solubles
A. Las Vegas Airport	2.9	3.8
B. Basic School	2.5	2.2
C. Clark County Health Dept.	2.8	5.2
D. Henderson Post Office	3.2	5.0
E. Las Vegas Fire Dept. No. 1	4.2	6.7
F. Las Vegas Fire Dept. No. 2	5.7	5.7
G. Nellis Air Force Base	3.6	2.7
H. North Las Vegas	4.8	4.5
I. Sahara Hotel	6.1	5.5
J. Las Vegas Stadium	-	-
K. Sunrise Power Plant	6.5	5.1
L. Las Vegas Wash	4.1	2.5

Source: Clark County District Health Department, Air Pollution Control Division.

The values of σ_y and σ_z are dependent on atmospheric stability class and a length factor, d, where

$d = \sigma_{yo} + S/2$, $\sigma_{yo} = S/4.3$, and S is the length of the side of a square grid. For 1 mi^2 area, S = 1 mile = 1.61 km, and so d ≈ 1.2 km. Using the most common stability class, D, σ_y and σ_z at 1.2 km are 80 m and 36 m, respectively. Assuming a wind speed of 9.5 mph (4.25 m/sec), the emission strength, Q, is calculated to be

$Q = (25\ \mu g/m^3)(\pi)(80\ m)(36\ m)(4.25\ m/sec)(1\ gram/10^6\ \mu g)$

$Q = 0.96$ g/sec from the 1 mi^2 area, or 0.96 $g/mi^2/sec$

$Q = (0.96\ g/mi^2/sec)(1\ ton/9.07 \times 10^5\ g)(3.1536 \times 10^7\ sec/yr)$

$Q = 33.4\ ton/mi^2/yr$

By averaging the two methods, the emission density from undisturbed surfaces having an average soil type is

$(50 + 33.4)/2 = 41.7\ ton/mi^2/yr$

This agrees with the original estimate of having to be less than 64 $ton/mi^2/yr$. Since this is only an approximation, a value of 40 $ton/mi^2/yr$ was used for this study.

Based on ratios of soil type correction factors found on page 4-5 of the Task B Report,[2] the emission density from gravelly soil is reduced to 7.5 $ton/mi^2/year$. For rocky soil and urban areas (grass, asphalt and concrete) the emissions from natural surfaces are negligible.

Emission Calculations

These factors were applied in the following manner. Soil type maps[5] were used to determine the percent of each soil type (loamy, gravelly, and rocky) in each grid, as indicated in the first three columns of Table 2.8. From land use maps,[6] the percentage of natural surfaces in each grid was estimated and entered in column four. It was assumed that the soil types were evenly distributed over each grid, rather than estimate on which soil type the

Table 2.8. EMISSIONS FROM NATURAL SURFACES IN LAS VEGAS

Grid	Percent soil types of entire grid			Percent natural surface of grid[d]	Total natural surface emissions, ton/year		
	loamy[a]	gravelly[b]	rocky[c]		1975	1980	1985
1		100		100	72.4	72.4	72.4
2		100		100	72.4	72.4	72.4
3		100		90	65.6	65.6	65.6
4		100		90	65.6	65.6	65.6
5		50	50	100	36.7	36.7	36.7
6		50	50	100	36.7	36.7	36.7
7		100		90	65.6	65.6	65.6
8		100		90	65.6	65.6	65.6
9		100		90	65.6	65.6	65.6
10		100		90	65.6	65.6	65.6
11		100		90	65.6	65.6	65.6
12		100		90	65.6	65.6	65.6
13		100		90	65.6	65.6	65.6
14		65	35	90	42.5	42.5	42.5
15		100		50	36.7	36.7	36.7
16		100		90	65.6	65.6	65.6
17		100		100	72.4	72.4	72.4
18		100		90	65.6	65.6	65.6
19		100		100	11.6	11.6	11.6
20	25	75		50	12.0	12.0	12.0
21		100		20	2.3	2.3	2.3
22	100			40	24.7	24.7	24.7
23	100			30	18.5	18.5	18.5
24	100			80	49.4	49.4	49.4
25	65	35		100	44.2	44.2	44.2
26	25	75		90	21.8	21.8	21.8
27		100		80	9.3	9.3	9.3
28		100		25	2.9	2.9	2.9
29		100		50	36.7	36.7	36.7
30		50	50	100	36.7	36.7	36.7
31		100		100	11.6	11.6	11.6
32	85	15		70	38.0	38.0	38.0
33		100		30	3.6	3.6	3.6
34	50	50		40	14.7	14.7	14.7
35	100			40	24.7	24.7	24.7
36	100			30	18.5	18.5	18.5
37	100			80	49.4	49.4	49.4
38	65	35		90	39.8	39.8	39.8
39		100		70	8.2	8.2	8.2
40		100		20	2.3	2.3	2.3
41	35	65		100	29.2	29.2	29.2
42	35	65		90	26.3	26.3	26.3
43	25	75		20	4.8	4.8	4.8
44	25	75		20	4.8	4.8	4.8

Table 2.8 (continued). EMISSIONS FROM NATURAL SURFACES IN LAS VEGAS

Grid	Percent soil types of entire grid			Percent natural surface of grid[d]	Total natural surface emissions, ton/year		
	loamy[a]	gravelly[b]	rocky[c]		1975	1980	1985
45	100			70	12.4	12.4	12.4
46	100			60	37.1	37.1	37.1
47	100			60	37.1	37.1	37.1
48	100			80	49.4	49.4	49.4
49	25	75		80	19.3	19.3	19.3
50	65	35		80	35.4	35.4	35.4
51		100		100	72.4	72.4	72.4
52		100		50	36.7	36.7	36.7
53	25	25	50	100	114.9	114.9	114.9
54		50	50	100	36.7	36.7	36.7
55	80	20		75	38.8	38.8	38.8
56	100			75	46.3	46.3	46.3
57	100			13	8.2	6.6	4.9
58	75	25		66	32.5	26.0	19.5
59	100			53	32.6	26.1	19.6
60	100			50	30.8	24.6	18.5
61	100			25	15.4	15.4	15.4
62	100			50	30.9	30.9	30.9
63	100			100	61.8	61.8	61.8
64	100			100	61.8	61.8	61.8
65	20	80		80	17.3	17.3	17.3
66	40	60		50	15.9	15.9	15.9
67	50	50		19	6.8	5.4	4.1
68	100			14	8.6	6.9	5.2
69	100			15	9.3	7.4	5.6
70	100			48	29.8	23.8	17.9
71	100			0	0.0	0.0	0.0
72	100			80	49.4	49.4	49.4
73	100			100	61.8	61.8	61.8
74	100			100	61.8	61.8	61.8
75		100		100	72.4	72.4	72.4
76		100		60	43.5	43.5	43.5
77		100		60	6.9	6.9	6.9
78		100		20	2.3	2.3	2.3
79	100			21	12.7	10.2	7.6
80	100			2	1.2	1.0	0.7
81	100			20	12.4	9.9	7.4
82	100			17	10.2	8.2	6.1
83	100			40	24.7	24.7	24.7
84	100			80	49.4	49.4	49.4
85	100			80	49.4	49.4	49.4
86	100			90	55.6	55.6	55.6
87		50	50	100	36.7	36.7	36.7
88		50	50	100	36.7	36.7	36.7

Table 2.8 (continued). EMISSIONS FROM NATURAL SURFACES IN LAS VEGAS

Grid	Percent soil types of entire grid			Percent natural surface of grid[d]	Total natural surface emissions, ton/year		
	loamy[a]	gravelly[b]	rocky[c]		1975	1980	1985
89		100		40	4.6	4.6	4.6
90		100		20	2.3	2.3	2.3
91	100			5	2.9	2.3	1.7
92	100			16	9.9	7.9	5.9
93	100			1	0.8	0.6	0.5
94	100			56	34.3	27.4	20.6
95	100			90	55.6	55.6	55.6
96	100			80	49.4	49.4	49.4
97	100			90	55.6	55.6	55.6
98	25		75	100	15.4	15.4	15.4
99		100		25	2.9	2.9	2.9
100		100		40	4.6	4.6	4.6
101	100			17	10.8	8.6	6.5
102	100			11	6.5	5.2	3.9
103	100			16	9.6	7.7	5.8
104	100			43	26.4	21.1	15.8
105	100			30	18.5	18.5	18.5
106	100			75	46.3	46.3	46.3
107	100			75	46.3	46.3	46.3
108		50	50	100	5.9	5.9	5.9
109		100		100	72.4	72.4	72.4
110		100		80	57.9	57.9	57.9
111		50	50	100	36.7	36.7	36.7
112		50	50	100	36.7	36.7	36.7
113		100		30	3.6	3.6	3.6
114		100		50	5.9	5.9	5.9
115	100			40	24.7	24.7	24.7
116	100			25	15.4	15.4	15.4
117	100			0	0.0	0.0	0.0
118	100			30	18.5	18.5	18.5
119	100			75	46.3	46.3	46.3
120	100			30	18.5	18.5	18.5
121	50	50		100	36.8	36.8	36.8
122		50	50	100	5.9	5.9	5.9
123	35	65		40	11.7	11.7	11.7
124	100			90	55.6	55.6	55.6
125	100			80	49.4	49.4	49.4
126	100			80	49.4	49.4	49.4
127	100			30	18.5	18.5	18.5
128	100			30	18.5	18.5	18.5
129	100			50	30.9	30.9	30.9
130	100			40	24.7	24.7	24.7
131	40	60		90	28.6	28.6	28.6
132		50	50	100	5.9	5.9	5.9

Table 2.8 (continued). EMISSIONS FROM NATURAL SURFACES IN LAS VEGAS

Grid	Percent soil types of entire grid			Percent natural surface of grid[d]	Total natural surface emissions, ton/year		
	loamy[a]	gravelly[b]	rocky[c]		1975	1980	1985
133		100		100	72.4	72.4	72.4
134		100		40	29.0	29.0	29.0
135	25	75		40	60.8	60.8	60.8
136	25	75		60	90.7	90.7	90.7
137	35	65		30	55.0	55.0	55.0
138	35	65		40	73.4	73.4	73.4
139		100		70	51.2	51.2	51.2
140		100		100	72.4	72.4	72.4
141		100		90	65.6	65.6	65.6
142	60	40		70	182.4	182.4	182.4
143	25	75		90	136.1	136.1	136.1
144	50	50		100	229.7	229.7	229.7
145		100		100	72.4	72.4	72.4
146		100		90	65.6	65.6	65.6
147		100		90	65.6	65.6	65.6
148		100		90	65.6	65.6	65.6

[a] Emission factor for loamy soil is 40 tons/mi^2/yr.

[b] Emission factor for gravelly soil is 7.5 tons/mi^2/yr.

[c] Emission factor for rocky soil is negligible.

[d] Percent natural surface assumed to be evenly distributed among the different soil types.

natural surfaces were located. The emission factors for each soil type were then factored by the percent of each soil type and the percent of natural surface in each grid. For example, in grid 53 in Las Vegas:

Soil type	Emission factor ton/mi^2/year	Percent soil type	Resultant contribution ton/mi^2/yr
loamy	40	25	10.0
gravelly	7.5	25	1.9
rocky	0.0	50	0.0

resultant emission factor = 11.9
percent natural surface 100

total emission factor for grid 53 = 11.9 ton/mi^2/yr

Applying this factor to grid 53, which is 5 km on a side, the emissions are (5 km x 5 km)(0.3861 mi^2/km^2)(11.9 ton/mi^2/yr) = 114.9 ton/year. Care should be taken to make sure the proper grid size is used for each grid. All grids were treated in a similar manner, except for those within the area outlined in Figure 5.3. Total vacant land acres for each grid within this area was supplied by The Clark County District Health Department.[7] It was assumed that these acres were both cleared areas and natural surfaces. Therefore, the cleared area acres in these grids, as determined in the microinventories of Task A,[4] were subtracted from the total vacant land acres. The remainder was assumed to be natural surface acres and was treated with the weighted emission factor as described above. The Clark County District Health Department also expects 40 percent of the vacant land in these grids to be developed by 1985.[7] Therefore, emissions in these grids were reduced by 20 and 40 percent in 1980 and 1985, respectively.

Natural surface emissions (Table 2.8) were kept separate from all other inventory source categories, but were added to the inventory totals from Tables 2.1, 2.2, and 2.3 for modeling purposes.

REFERENCES FOR SECTION 2

1. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task C Report, Emission Inventory and Emission Projections. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. May, 1976.

2. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task B Report, Factors Influencing Emissions from Fugitive Sources. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. January 1976.

3. Communication with M. Janette Smith, Clark County District Health Department, August 12, 1976.

4. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task A Report, Air Quality Monitoring Data. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. January, 1976.

5. Soil Survey, Las Vegas and Eldorado Valleys Area, Nevada. U.S. Department of Agriculture, Series 1957, No. 23. February, 1967.

6. Existing Land Use, Regional Comprehensive Plan. Clark County Regional Planning Council. October, 1975.

7. Communication from Harold A. Bres, Jr., Air Pollution Control Division, Clark County District Health Department. September 10, 1976.

3. MODEL DESCRIPTION

To evaluate the impact of control strategies, it is necessary first to develop a relationship between emissions and air quality. Several diffusion modeling techniques have been suggested by the U.S. Environmental Protection Agency[1] for this purpose, including: Miller-Holzworth, AQDM, and Hanna-Gifford. The Hanna-Gifford approach was evaluated for applicability based on several reasons. The emission density vs. air quality relationship developed in the Task A Report[2] showed a reasonable correlation, but not high enough to be used to estimate air quality. The Hanna-Gifford simulation is a more sophisticated approach to emission density and air quality relationships and is expected to give a better correlation. Few major (tall stack) point sources are present in the study area. These sources would be evaluated poorly by Hanna-Gifford. This model best accomodates sources with low-level emission heights. This is typical of the source categories in the study area. Fugitive dust sources are generally ground level.

The basic model is an expression developed by S.R. Hanna and F.A. Gifford[3] to calculate the impact of various sources on a central receptor over a long period of time. The expression, the result of integrating the receptor-oriented Gaussian plume equation over upwind area sources (grids), is:

$$\chi = \sqrt{\frac{2}{\pi}}\,\frac{1}{u}\,\frac{(\Delta x/2)^{1-b}}{a(1-b)}\left\{ Q_o + \sum_{i=1}^{n} Q_i\left[(2i+1)^{1-b} - (2i-1)^{1-b}\right]\right\}$$

where

χ = concentration in a grid, $\mu g/m^3$

u = wind speed, m/sec

Δx = grid width, m

a,b = stability coefficients ($a = 0.15$, $b = 0.75$ for urban areas)

Q_o = source strength of receptor grid, $\mu g/m^2$-sec

Q_i = source strength of i^{th} grid away from the receptor grid, $\mu g/m^2$-sec

n = number of grids in any one direction which will have a significant impact on the receptor grid, for this study assume $n = 2$.

For an area marked off in grids of a given size, the quantity

$$\sqrt{\frac{2}{\pi}}\ \frac{(\Delta x/2)^{1-b}}{a(1-b)} = \text{constant} = C$$

For a 2 km grid, $\Delta x = 2000$ m and $C = 119.6$.

For a 5 km grid, $\Delta x = 5000$ m and $C = 150.5$.

It was assumed that the air quality of each receptor grid is affected not only by the emissions of that grid but also by the emissions from two rings of surrounding source grids. The quantity within the square brackets [ ] in the first equation expresses the relative contribution of these emissions based on distance in terms of number of grids (i) away from the receptor. This scheme has been modified for this study by assuming that the impact of the source grid emissions on a receptor grid is proportional to the distance between the centers of these grids in relative grid widths.

In the original model, for each grid in the ring of grids nearest the receptor the relative impact of the emissions is the same, since for each of these grids $i = 1$. In the modified version $i = 1.00$ for grids which have a side in common with the receptor grid. However, for grids which lie on the diagonal of the central grid, i = 1.41. Consequently, emissions from these grids have a lesser impact than those from grids having a common side with the receptor.

Note, the grid sizes cannot be mixed. Impact on a receptor must be calculated from source grids of an equivalent size. Therefore, in order to estimate air quality in those 2 km grids which are nearest the 5 km grids, it was necessary to create two rows of artificial 2 km grids whose emissions were fractional parts of the emissions of the corresponding 5 km grids. Two rows of artificial 5 km grids must, likewise, be created around the entire grid network. Since an emission inventory for these areas does not exist, the emissions of the perimeter grids were repeated. This appears to be a valid assumption in light of the fact that the two areas, gridded and non-gridded, have a similar make-up, and that if these areas were assumed to have zero emissions the air quality impact might be severly underestimated. Also, within the central part of the grid system, artificial 5 km grids were composed of combinations of 2 km grids.

Meteorological conditions will also have an effect on air quality. The impact of the emissions from each source grid was weighted based on the frequency of occurrence of the wind out of the direction that grid lies from the receptor. Wind speed was also varied with wind direction. Historical data[4] and a sixteen-point compass were used.

The emission inventory data presented in Tables 2.1 and 2.8 were used to calibrate the model. Measured annual geometric mean concentrations were correlated against the modeled air quality at each of the ten sampling stations in Las Vegas. Very few sampling stations were located at the center of a grid. Therefore, the modeled air quality was obtained by weighting the modeled impact from each grid which at least partially occupies an imaginary grid of equal size having a sampling site at its center. The grids at each sampling site, their allocation factors, and the results of this correlation procedure are shown in Table 3.1. Correlation results (0.69) show that the Hanna-Gifford approach is an acceptable diffusion model to use in this study. Statistical analyses support the assumption that this correlation does indeed show that there is a significant relationship between measured and modeled air quality using the Hanna-Gifford model. The slope and intercept are the parameters required to calibrate the model for comparison to actual data.

The intercept of the correlation is normally assumed to be an indication of background concentration which is unaccounted for by any known source of emissions within a given area. Although the intercept of the correlation is provided by the best fit of a line through measured versus modeled data, the value 51.3 shown in Table 3.1 is not representative of background levels in Las Vegas. The Clark County District Health Department suggested using a background value of 35 $\mu g/m^3$ based on three year running averages from their background station.[5] Due to the large intercept obtained from the correlation, several other methods were investigated in an attempt to develop an improved relationship between measured and modeled data. Separate correlations for high and low concentrations, and for urban and rural concentrations, however, provided no better relationship. The average difference between measured and modeled data, which may also be used as an indication of background, also failed to improve the relationship. This value of 51.7 $\mu g/m^3$ did not favorably agree with background levels measured by the local agency. An attempt

Table 3.1. CORRELATION OF LAS VEGAS ANNUAL GEOMETRIC MEANS WITH MODELED AIR QUALITY

Site	Grids	Uncalibrated model impact μg/m^3	Allocation factors	Grid contribution μg/m^3	Modeled air quality at site μg/m^3	Measured annual geometric mean[a] μg/m^3
A, Las Vegas Airport	33	6.8	1/2	3		
	43	43.8	1/2	22	25	69
B, Basic School	15	9.6	2/3	6		
	29	20.7	1/3	7	13	64
C, Clark Cc. Health Dept.	91	47.3	5/8	29		
	101	33.5	3/8	13	42	91
D, Henderson Post Office	28	14.4	1/4	4		
	29	20.7	1/4	5		
	40	87.0	1/2	43	52	92
E, Las Vegas Fire Dept. 1	92	70.0	1/4	17		
	102	43.6	3/4	33	50	82
F, Las Vegas Fire Dept. 2	93	42.3	1/2	21		
	94	27.0	1/2	14	35	105
G, Nellis Air Force Base	138	8.4	1/1	8	8	51
H, North Las Vegas	117	32.0	1/1	32	32	105
I, Sahara Hotel	79	39.7	1/2	20		
	80	43.0	1/2	21	41	117
J, Las Vegas Stadium	50	25.4	1/1	25	25	64
K, Sunrise Power Plant[b]	73	33.0	1/8	4		
	85	168.8	7/8	148	152	92
L, Las Vegas Wash.[c]	-	-	-	-	-	32
Correlation					0.689	
Slope					1.012	
Intercept					51.320	

[a] Calculated using October 1974 through September 1975 data.

[b] Site K was not included in the correlation because of an apparent sampling site bias.

[c] Site L was not included in the correlation because it is located outside of the gridded study area.

to force-fit a line through the suggested background value of 35 $\mu g/m^3$ would result in a calibration which would overpredict the large concentrations and underpredict the low ones.

Based on the investigation described above, it was decided to use the slope of the original correlation, shown in Table 3.1, and the background value (intercept) of 35 $\mu g/m^3$ suggested by the Clark County District Health Department. All subsequent model runs predict air quality concentrations according to the following expression:

predicted air quality = (1.012)(modeled air quality) + 35.

This equation produces predicted concentrations which are on the order of 16 $\mu g/m^3$ lower than those which would result if the correlation intercept were used.

Note that model results are not to be considered as absolute ambient air concentrations. A model provides relative magnitudes of concentrations which should be considered as aids to the user in decision making. For example, Figure 4.1 shows the 1975 predicted air quality in Las Vegas. These are relative concentrations, not values to be looked upon as actual air quality. In grid 117, the modeled concentration is shown to be 68 $\mu g/m^3$, while the actual measured concentration at site H is 105 $\mu g/m^3$. Figure 4.2 shows the 1985 predicted air quality in grid 117 to be 75 $\mu g/m^3$. The relative increase in predicted values from 1975 to 1985 is 8 $\mu g/m^3$. Thus, due to the expected growth during this ten year period, the actual air quality in grid 117 is expected to increase on the order of 8 $\mu g/m^3$ from 105 $\mu g/m^3$ to 113 $\mu g/m^3$. Here the model has provided information on what relative change in air quality might be expected, even though the predicted concentration is only a percentage of the actual ambient concentration. Since it is only necessary to determine the relative differences in air quality when evaluating the effects of any control strategy, all subsequent model runs show air quality calibrated according to the expression shown above. Thus, the relative differences between predicted air quality before and after the application of control strategies will be on the order of those which the control strategies are expected to produce on actual concentrations.

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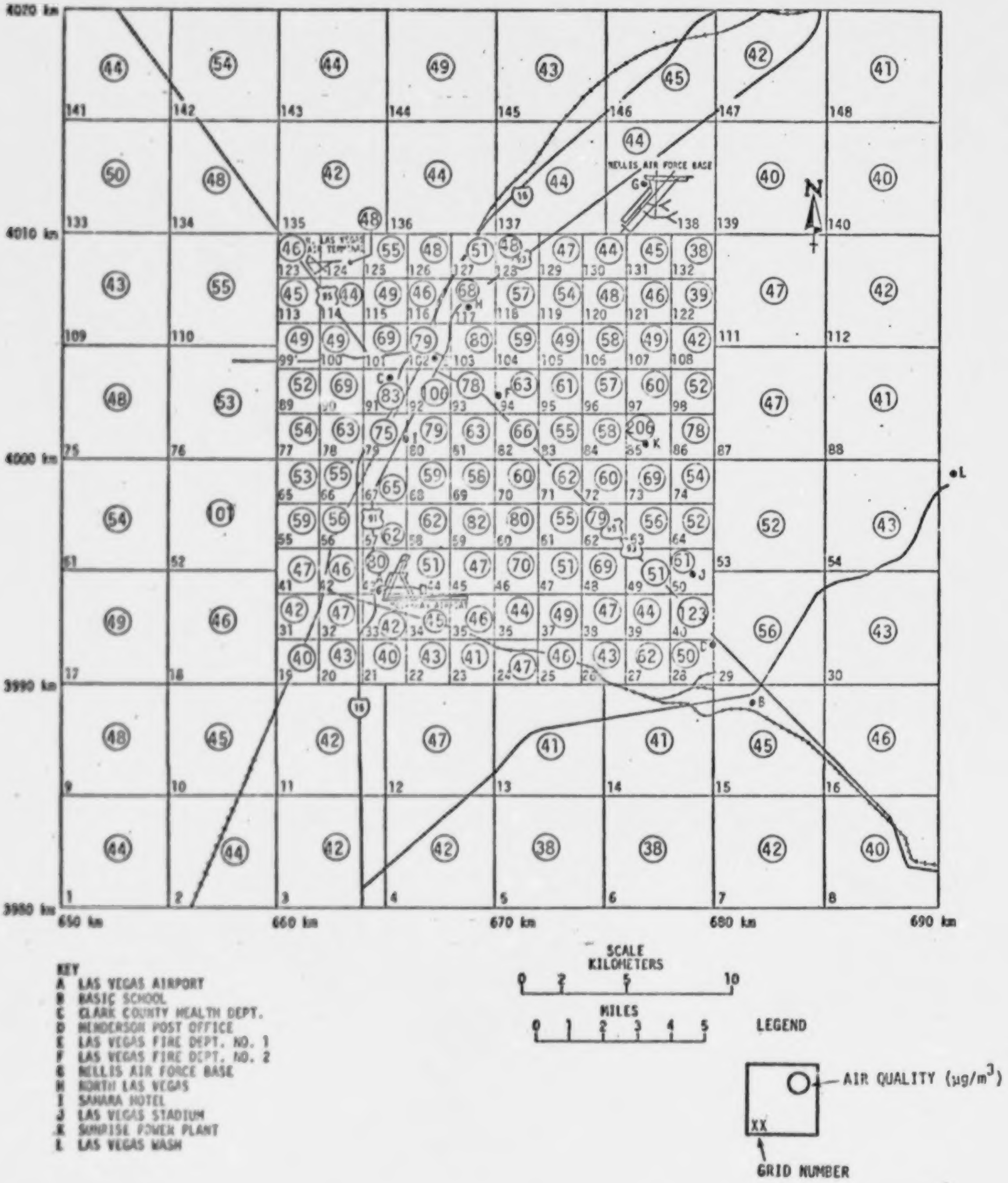
3. A Simple Method of Calculating Dispersion from Urban Area Sources. Steven R. Hanna, Journal of the Air Pollution Control Association. December 1971.

4. National Climatic Center, U.S. Department of Commerce. Asheville, North Carolina.

5. Communication from M. Janette Smith, Air Pollution Control Division, Clark County District Health Department. August 12, 1976.

4. MODELED AIR QUALITY

The 1975 Las Vegas air quality, as determined by the model described in Section 3, is shown in Figure 4.1. The air quality in $\mu g/m^3$ is indicated in each grid by an encircled number. Figure 4.2 is a similar diagram showing projected 1985 air quality. A slight increase in modeled concentrations can be observed in each grid. This result might be expected based on increased emissions due to growth from 1975 to 1985. As shown in Task F, particle size distributions were determined from glass fiber filter samples at three sites in Las Vegas. The average percent by weight of all particles less than 5.3 μm, assumed to be the particle size cutoff for respirable material, was calculated to be 7.4 percent. By multiplying all 1975 modeled concentrations by this percentage, the concentration of respirable material in the ambient air in 1975 is obtained. These respirable concentrations are shown in Figure 4.3.



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NELLIS AIR FORCE BASE
LAS VEGAS TERMINAL
N
KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
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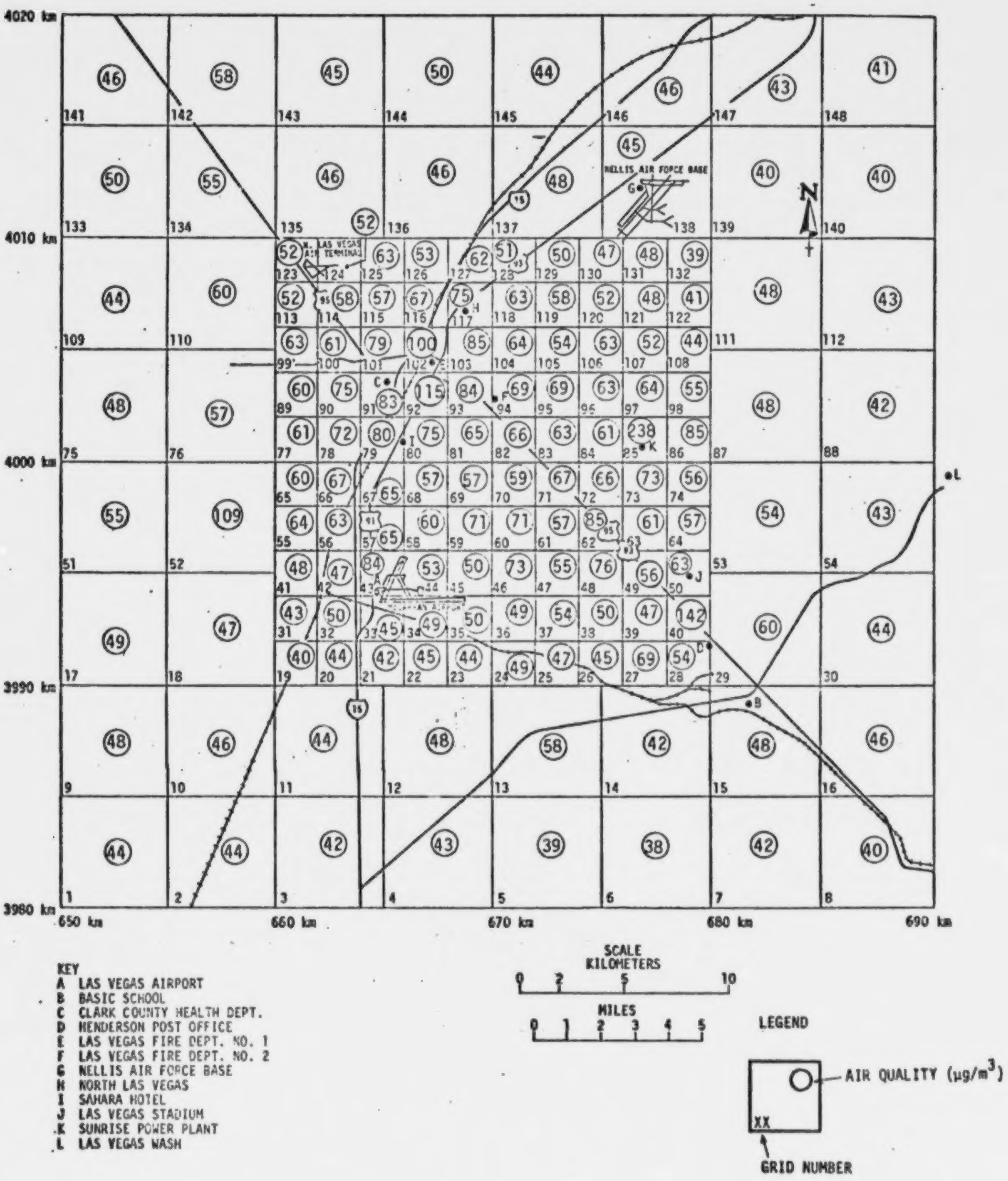
GRID NUMBER

Figure 4.1 1975 Las Vegas modeled air quality.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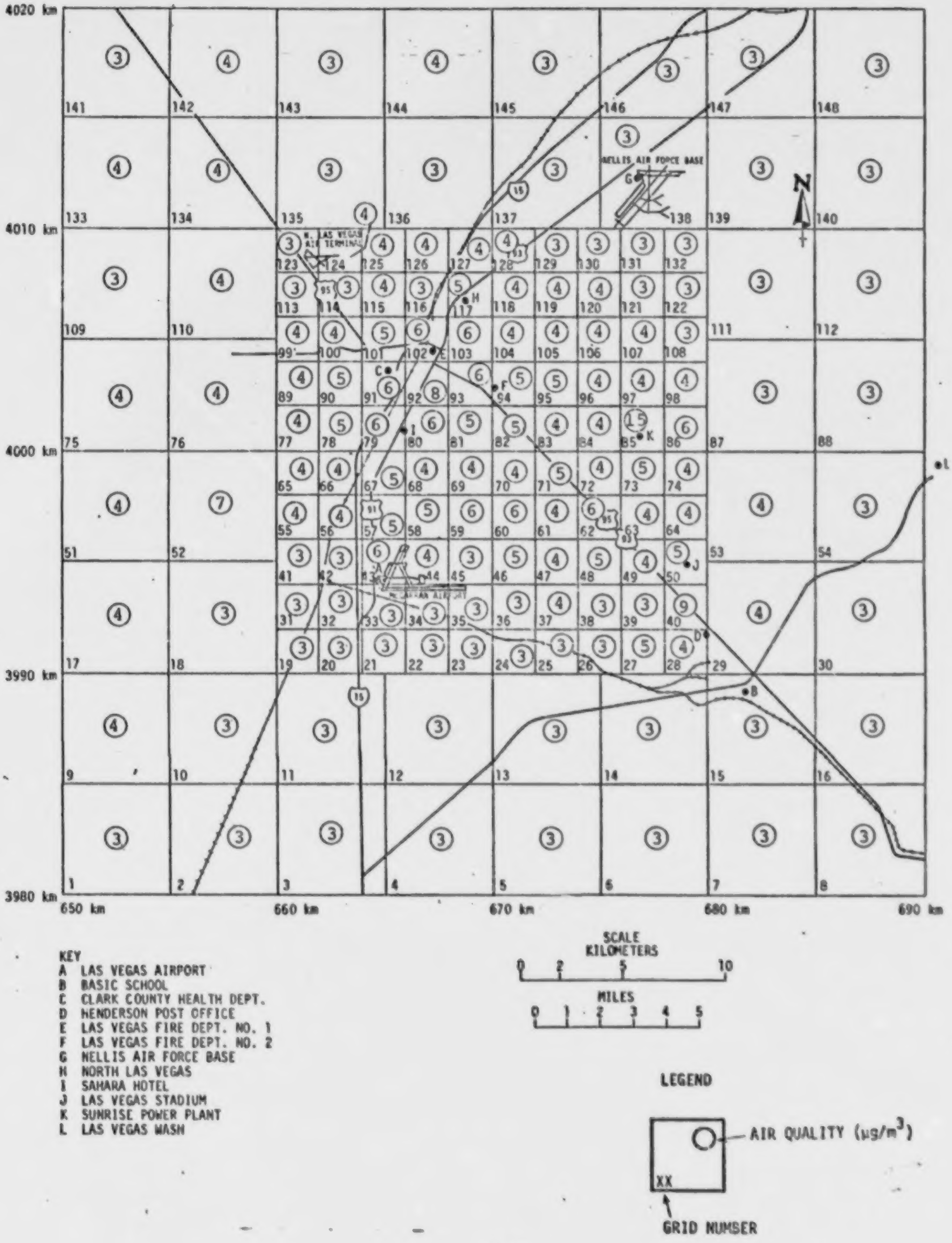
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
LEGEND
AIR QUALITY (μg/m³)
XX
GRID NUMBER

Figure 4.2 1985 Las Vegas modeled air quality.[a]

[a] Present emissions are based on existing programs. They do not include reductions attributable to control strategies described in Section 7.0.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K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
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MILES
0 1 2 3 4 5
LEGEND
AIR QUALITY (μg/m³)
XX
GRID NUMBER

Figure 4.3 1975 Las Vegas modeled respirable air quality.

5. CONTROL STRATEGIES

Several control possibilities were discussed with Clark County District Health Department, Air Pollution Control Division personnel. These strategies were designed to affect the major source categories in the study area. Initially, the following strategies were considered:

Street cleaning,
Stationary source control,
Stabilization of railroad yards,
Control of construction emissions,
Reduction of emissions from cleared areas, and
Reduction of unpaved road emissions.

All of these strategies, except control of construction emissions, were then evaluated using the Hanna-Gifford relationship. The current regulations on construction are considered by the agency as adequate; their limiting factor being enforceability. The others were evaluated by first determining the emission reduction efficiencies that are expected for each strategy. A weighing factor was then applied to better estimate the actual impact on air quality that each strategy will have. This is explained in Section 6. The resulting emissions were then input to the Hanna-Gifford model to predict the resultant air quality. These results are shown in Section 7.

STREET CLEANING

This control strategy involves a regular schedule of paved street cleaning using mobile vacuum cleaning equipment.

Paved street cleaning is expected to reduce the reentrainment of particulates which have accumulated due to normal deposition year-round. The percent reduction in these emissions is calculated based on the following assumptions:

1) vacuum sweeper removal efficiency is 75% on streets maintaining a maximum particulate loading,
2) particulates accumulate as shown in column 2 of Table 5.1,
3) streets will again attain maximum loading 7 days after cleaning,
4) streets will be cleaned every seven days.

Table 5.1 shows the calculations involved in determining an average percent reduction in paved street emissions. Since vacuum sweepers are not one-hundred percent efficient, a residual amount of particulates will remain on the streets after cleaning. In addition to any residual loading, particulates will accumulate as shown in column 2 of Table 5.1.[1] Total street loading (accumulation plus residual) will increase each day since the last cleaning, until a maximum or equilibrium loading is attained on the seventh day, after which the total loading remains constant. The residual loading is that amount which is never removed from the streets regardless of how often the streets are cleaned. Thus, only the additional accumulation is removed during cleaning. The maximum accumulation is expected to occur seven days after cleaning and will amount to 800 lb/curb-mile. The literature reports a vacuum sweeper efficiency of 95.3 percent.[2] However, this efficiency was determined under test conditions. Less than ideal conditions are often encountered in actual applications. Undulations in the pavement, such as sewer openings, and the detours street

Table 5.1 PERCENTAGE OF MAXIMUM STREET LOADING BY NUMBER OF DAYS SINCE CLEANING

Days since cleaning	Accumulation since cleaning, lb/curb-mile[a]	Residual loading, lb/curb-mile	Total street loading, lb/curb-mile	Average street loading, lb/curb-mile	Average loadings, percent of maximum	Percent reduction in maximum loading due to cleaning
1	175	270	445	445	42	58
2	325	270	595	520	49	51
3	425	270	695	578	54	46
4	525	270	795	633	59	41
5	625	270	895	685	64	36
6	700	270	970	733	69	31
7	800	270	1070	780	73	27
8	800	270	1070	817	76	24
9	800	270	1070	845	79	21
10	800	270	1070	868	81	19

Based on vacuum cleaner removal efficiency of 75% and removal of maximum accumulation of 800 lb/curb-mile, the residual loading is calculated by ratio to be (800 lb/curb-mile removed) (25% residual/75% removed) = 270 lb/curb-mile which remains constant.
Accumulation and, therefore, total street loading will increase each day since the last cleaning until a maximum or equilibruim loading (maximum accumulation plus residual) of 800 + 270 = 1070 lb/curb-mile is attained on the seventh day, after which the total loading remains constant.

For a 7 day cleaning cycle:

Average daily loading = (445 + 595 + 695 + 795 + 895 + 970 + 1070)/7 = 780 lb/curb-mile
Percent of maximum loading = (780/1070) x 100% = 73%
Reduction in loading = 100% (maximum loading) - 73% of maximum loading due to 7 day cleaning cycle = 27%
Percent emission reduction = 27%

[a] Reference 1.

cleaners must take to avoid parked cars are expected to reduce the cleaning efficiency to 75 percent. Therefore, the maximum or equilibrium loading (maximum accumulation plus residual) is calculated by dividing the amount removed during cleaning (maximum accumulation) by the efficiency of the street cleaner itself. Thus, the maximum loading is

$$\frac{800 \text{ lb/curb-mile}}{\text{efficiency, } 0.75} \simeq 1070 \text{ lb/curb-mile}$$

The residual loading (maximum minus accumulation) is, therefore, 1070-800=270 lb/curb-mile which is never removed from the street.

In Table 5.1, the total loading by number of days since cleaning (column 4) is the sum of the accumulation by day (column 2) plus the residual (column 3). The average street loading (column 5) is the average of the total street loadings for each number of days since the last cleaning. If the streets were never cleaned again, the average loading would eventually reach a maximum of 1070 lb/curb-mile. Column 6 shows the average percent of maximum loading which the streets would maintain due to a cleaning cycle of each given number of days. The reduction from the maximum loading is shown in column 7. For example, if the streets were cleaned every three days the average loading would be (445 + 595 + 695)/3 = 578 lb/curb-mile, or (578/1070) x 100% = 54 percent of the maximum loading. Conversely, the percent reduction in the loading is 100-54 = 46 percent. The reduction in street loading is directly proportional to the reduction in fugitive dust emissions from paved streets. Therefore, a 46 percent reduction in the street loading results in a 46 percent reduction in emissions. Similarly, a 7-day cleaning cycle has an average loading of 780 lb/curb-mile, or 73 percent of the maximum loading, and results in a 27 percent reduction in emissions. For the implementation of this control strategy a conservative estimate of the average removal efficiency of 25 percent was used due to the inaccuracies involved in the development of the accumulations shown in column 2 of Table 5.1.

The Nevada State Highway Department has designated eight road classifications: local, minor arterial, major arterial, collector, ramp, interstate, freeway, and expressway. Of these only the first four types are subject to street cleaning. Since emissions are based on VMT, only emissions due to the percentage of travel on these four road types will be affected. Street cleaning operations will be conducted within the city limits of Las Vegas and North Las Vegas. Also included is an area south of the city to Tropicana Avenue between Interstate 15 and Eastern Avenue, and a stretch of Boulder Highway from East Sahara Avenue to Tropicana Avenue. Emissions from all other rural grids will not change.

It was assumed that the curb or shoulder lane on each side of all paved roads is to be cleaned. The total number of miles to be cleaned within the boundaries described above is:[4]

Las Vegas	500	
North Las Vegas	196	
Clark County	96	
	792	paved street miles
	x2	directions
	1,584	cleaned miles

It was also assumed that a single cleaner could treat 30 miles of pavement per day. Therefore, in order to clean all pavement once a week, the number of cleaners required is

$$1{,}584\ \frac{\text{miles cleaned}}{\text{week}} \times \frac{\text{day}}{30\ \text{miles cleaned}} \times \frac{\text{week}}{7\ \text{days}} \simeq 8\ \text{cleaners}$$

The capital cost[5] of 8 cleaners at $45,000 per cleaner is $360,000. Operating and maintenance cost[5] are $15,000-$25,000 per cleaner per year. Thus, annual operating cost for 8 cleaners is $120,000 to $200,000.

STATIONARY SOURCE CONTROL

This strategy involves the control of emissions from point and area sources over and above the control, if any, which currently exists. The sources subject to control under this strategy are those associated with the aggregate industry. Specifically, point sources include crushing and screening operations associated with sand and gravel plants; area sources include excavation, loading and unloading, storage piles, haul roads and traffic areas. Concrete and asphalt batching, lime kilns, metal processings and refining operations are not included. It is assumed that an 85 percent reduction in emissions from point sources can be achieved with baghouses. This is an engineering judgment in which the reduction from a 99+ percent efficiency is due to hood capture inefficiencies. A 50 percent reduction in area source emissions can be achieved by watering.[3]

The cost of implementing this control strategy was obtained by summing the costs of control for each source. By knowing the production capacity of each point source,[6] the cost of controlling their emissions can be obtained from the total cost curve in Figure 5.1. The summation of the capital and installation costs for these sources is $1,386,000.

Area sources can be controlled by watering twice daily at a cost rate of $2-5/acre/day.[3] From the microinventory surveys, 103 acres of active and 317 acres of inactive sand

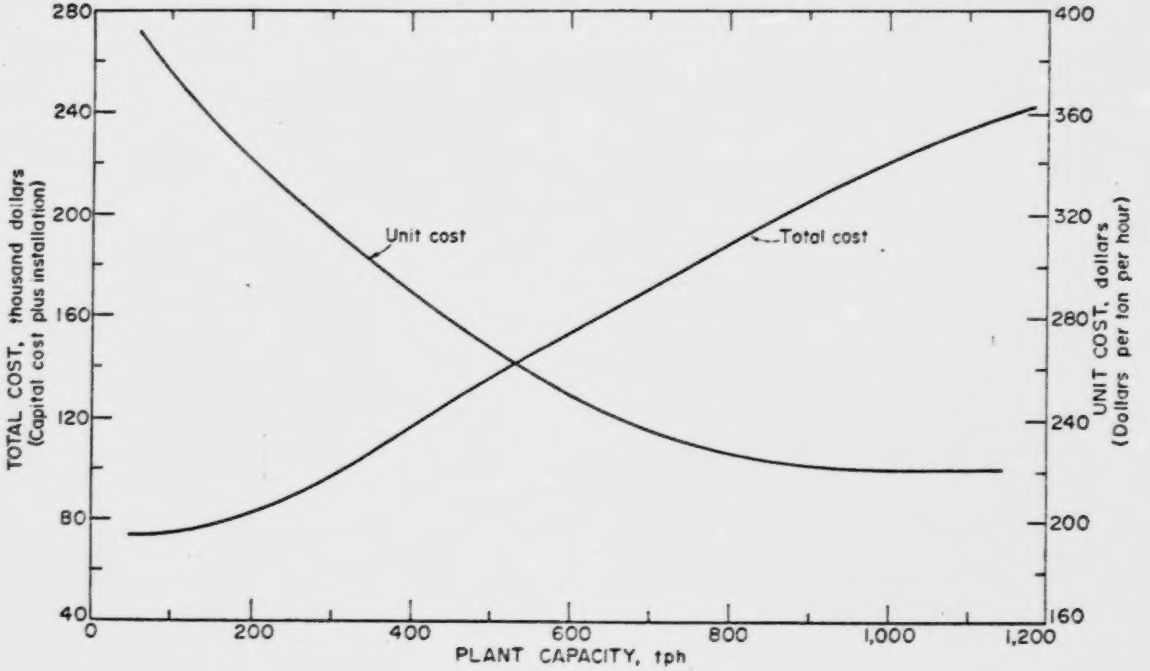

Figure 5.1 Cost estimates for equipping a typical stone crushing plant with a fabric filter system.[7]

and gravel pit operations were indentified.[8] Under this strategy, only the active acres will be watered. Assuming that watering is done 5 days per week, 50 weeks per year, the annual cost of watering is $52,000 to $130,000.

STABILIZATION OF RAILROAD YARDS

This control strategy involves the reduction of emissions from railroad yards by means of chemical stabilization. A stabilizer is any of numerous products which are used to form a film or crust over the area to which it is applied in order to prevent wind or water erosion of the surface. In non-traffic areas such as road shoulders or railroad right-of-ways, chemical soil stabilization has proven highly effective in reducing the dust produced by air disturbances from passing vehicles. The main portion of railyard affected by this control strategy runs parallel to South Main Street between West Charleston Boulevard and the Las Vegas Expressway. It was assumed that an 80 percent reduction in emissions could be achieved by stabilization.[3]

The cost of chemical stabilizers for dust control ranges from $87 per acre to $720 per acre.[9] The railyard affected by this strategy is approximately 134 acres which places the annual cost of the chemicals between $11,700 and $96,500. This is the cost of the chemicals only and does not include the cost of application.

SOIL STABILIZATION

Emissions from cleared areas and natural surfaces can also be effectively reduced by chemical stabilization. Chemical stabilizers can be divided into two categories: those which prevent wind and water erosion by sealing the surface with an impervious crust, and those which, while preventing erosion by their binding and film forming properties, allow the surface to become pentrated by rain and sunlight. The characteristic of penetration is one which permits a stabilizer of the latter type to be applied over a seeded area and still allows germination to occur. Some stabilizers of this type will dissolve with the first rain and must be reapplied, while others maintain their properties for up to two years. On cleared areas and natural surfaces it may be desirable to use a stabilizer which will maintain its properties until any bound seed has germinated and reached a mature growth. Once this has occurred the vegetation will act as a natural stabilizer and reapplication of the chemical will not be necessary.

This control strategy would be applied only to that area outlined in Figure 5.2. It was assumed that an 80 percent reduction in emissions from this area could be achieved.[3]

The cost rate of stabilization of cleared areas and natural surfaces is the same as that for railyard stabilization, $87-720 per acre.[9] This is the cost of the chemicals only and does not include the application costs, which are highly site specific. One example of stabilizer cost is that of Coherex[a] at McCarran Airport. Application is required once or twice a year. Material cost is $0.38 per gallon undiluted. Before application one part stabilizer is

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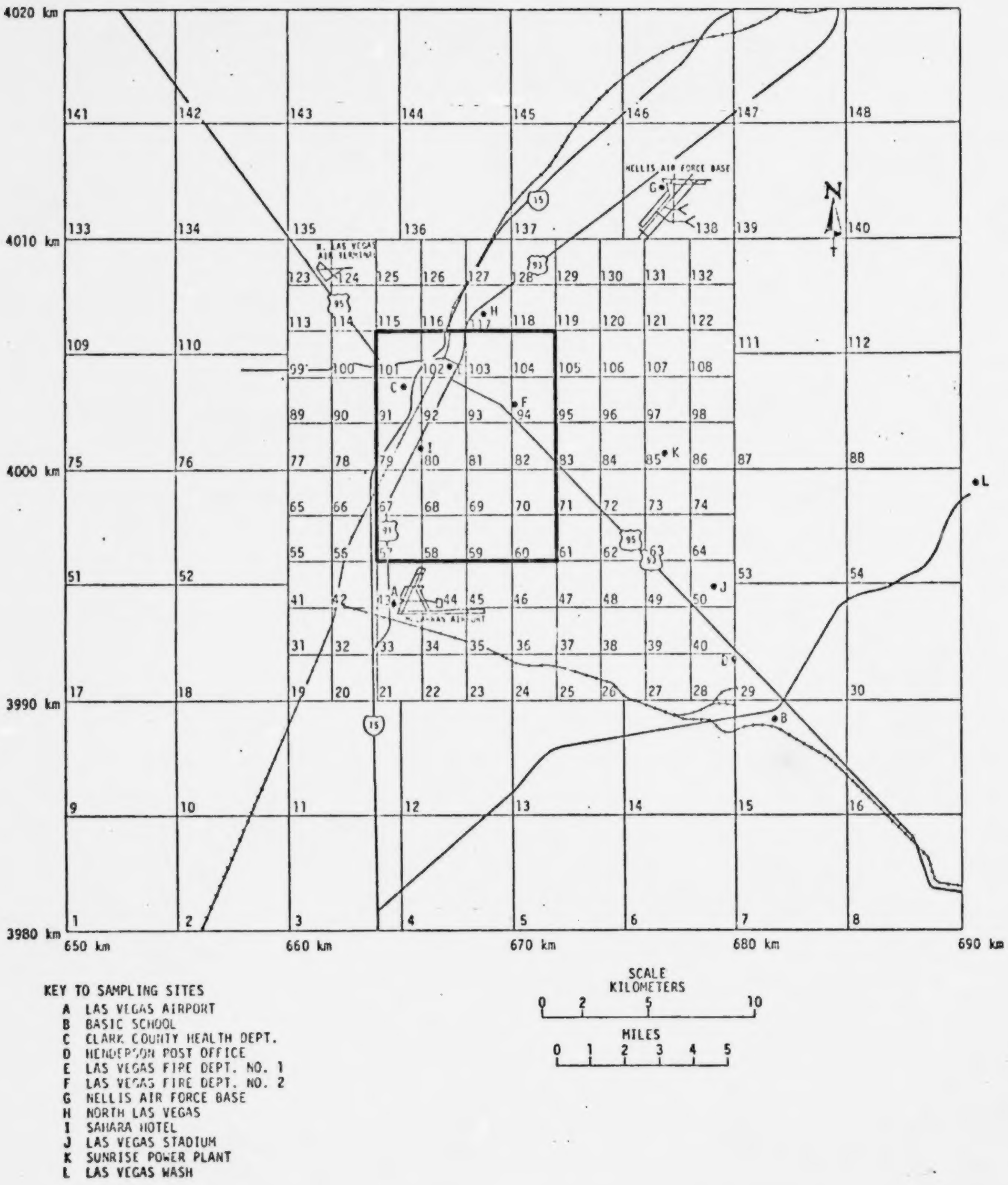
[a] Mention of company or product name is not to be considered an endorsement by the U.S. Environmental Protection Agency.



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0 2 5 10
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0 1 2 3 4 5
KEY TO SAMPLING SITES
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH

Figure 5.2 Area affected by soil stabilization and chemical treatment of unpaved roads.

diluted with three parts water to make the cost approximately \$0.10 per gallon applied. The diluted mixture is sprayed 1/2 gallon per square yard from water trucks. Per acre the amount of material applied is

$$(4840\ \text{yd}^2/\text{acre})(0.5\ \text{gallon}/\text{yd}^2) = 2420\ \text{gallons/acre}$$

and the material cost is

$$(2420\ \text{gallons/acre})(\$0.10/\text{gallon}) = \$242/\text{acre}$$

Watering trucks can apply 2000-4000 gallons per hour at a cost of \$19 per hour for capital and labor. With this application rate, between 0.8 and 1.7 acres can be treated per hour. Assuming a mid-range of one acre treated per hour, the cost of applying the stabilizer is \$19 per acre. Therefore, total applied cost (material and labor) is approximately \$260 per acre. Additional information on the material cost of other chemical stabilizers[9] is given in Appendix A.

The Clark County District Health Department has indicated that there is currently 5,950 acres of vacant land within the outlined area shown in Figure 5.2.[4] The cost of controlling fugitive emissions from this land is \$518,000 to \$4,284,000 annually. The application of certain chemical stabilizers would not be required each year, whereas the application of certain others would be required more often. Effective control will also depend on whether or not these areas are free of traffic. If traffic is permitted on a chemically stabilized surface, the crust will be destroyed making reapplication of the stabilizer necessary.

UNPAVED ROAD CHEMICAL TREATMENT

Emissions from unpaved roads may be reduced by means of chemical treatment. Surface treatment with penetration chemicals or soil stabilizers worked into the roadbed may account for a 50 percent reduction in emissions. The area affected by this control strategy is that outlined in Figure 5.2.

Chemical treatments applied to road surfaces have a somewhat different nature than those applied to control dust in non-traffic areas. Stabilizers used for this purpose are generally a type of cut-back asphalt, which have properties similar to asphalt, but are not quite as durable. The cost of road type stabilizers, although not as high as that of standard pavement products, is higher than the cost of regular soil stabilizers. These costs range from \$440 to \$1,750 per acre.[9] If a roadway is assumed to be 20 ft. wide, this cost converts to \$1,100 to \$4,300 per mile. The cost of treating 2.6 miles of unpaved roads within the outlined area in Figure 5.2 is, therefore, \$2,800 to \$11,000.

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9. Unpublished Survey of Chemical Stabilizers, Cost and Applications. PEDCo-Environmental Specialists, Inc. September, 1976.

6. WEIGHTING FACTORS

In attempt to estimate more closely the impact on air quality that will be expected from emission reductions, development of a weighting factor was investigated in the Task F Report, Particulate Characterization Study.[1] This factor was developed because of the large disparity between the percent mineral observed on hi-volume sampler filters and the percent mineral emissions in the microinventories surrounding the hi-vol sites. A much higher percent of the emissions were mineral than were collected on the filters. Therefore, a reduction in mineral emissions can not be expected to result in an equal reduction in filter loading.

From the microinventory of selected sites in Las Vegas, shown in Tables 6.1, 6.2 and 6.3, all emissions were identified and classified as being from mineral, tire wear, or combustion sources. Also, high volume samples (millipore and glass fiber), which were taken at these sites, were analyzed under Task F for the percent by weight of material from the same source classifications. The mineral percentage by weight of both the emissions and the filter loadings are shown in Table 6.4.

It has been observed that a high percentage of all microinventory emissions at the selected sites are from mineral sources. One would expect a similar percentage of minerals to appear on the sample filters. This, however, was not the case. On the average, the sample filters showed a percentage of mineral impact which was only 60 percent of the percentage of mineral emissions. Therefore, reductions

Table 6.1. MICROINVENTORY OF PARTICULATE EMISSIONS AT HENDERSON POST OFFICE SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	8.4 acres	2.16-2.40 ton/ac/yr[a]	19.2		
Unpaved roads	209.5 VMT/day	5.3 lb/VMT	202.6		
Normal paved roads	66,066 VMT/day	1.75 gm/VMT	42.2		
Sand and gravel pits	12.3 acres active	3.4 ton/ac/yr	41.8		
Unpaved parking lots	3.7 acres	0.74 ton/ac/yr	2.7		
Heavy equipment storage	8.0 acres	1.34 ton/ac/yr	10.7		
Stationary area source fuel combustion[b]					6.0
Motor vehicles[c]	66,066 VMT/day	0.0013 lb/VMT		6.4	9.6
Point source			180.0		
Total			499.2	6.4	15.6
Percent of total			96	1	3

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] See summary table in Task C report.

[c] Assume 60 percent of emission are due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table 6.2. MICROINVENTORY OF PARTICULATE EMISSIONS AT SAHARA HOTEL SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Active construction	88 acre-months	1.0 ton/ac/mo	92.0[a]		
Cleared areas	179.2 acres	0.44-1.34 ton/ac/yr[b]	142.9		
Unpaved roads	32 VMT/day	5.3 lb/VMT	31.0		
Normal paved roads	273,668 VMT/day	1.75 gm/VMT	174.9		
Unpaved parking lots lots	12,143 VMT/yr plus 4.25 acres	1.8 lb/VMT 0.74 ton/ac/yr	14.0		
R.R. right of ways	4.1 acres	0.9 ton/ac/yr	3.7		
Heavy equipment storage	7.5 acres	1.34 ton/ac/yr	10.1		
Dirty paved roads	28,410 VMT/day	28 gm/VMT	319.7		
Stationary area source fuel combustion[c]					2.0
Motor vehicles[d]	317,946 VMT/day	0.0013 lb/VMT		30.2	45.2
Railroads	51,392 gal/yr	0.025 lb/gal			0.6
Point source			7.0		
Total			795.3	30.2	47.8
Percent of total			92	3	5

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[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] See summary table in Task C report.

[d] Assume 60 percent of emissions are due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table 6.3. MICROINVENTORY OF PARTICULATE EMISSIONS AT SUNRISE POWER PLANT SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	6.1 acres	1.14-1.28 ton/ac/yr[a]	7.4		
Normal paved roads	400 VMT/day	1.75 gm/VMT	0.2		
Sand and gravel pits	19.7 acres active	3.4 ton/ac/yr	68.6		
	1.4 acres inactive	1.4 ton/ac/yr			
Unpaved parking lots	415 VMT/yr	1.8 lb/VMT	0.4		
Agriculture	23 acres	tilling 0.49 ton/ac/yr windblown 0.11 ton/ac/yr	13.8		
Stationary area source fuel combustion[b]					3.4
Motor vehicles	400 VMT/day	0.0013 lb/VMT		Neg.	Neg.
Point source[c]			364		
Power plant[d]					
Total			454.4		3.4
Percent of total			99		1

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] See Summary table in Task C report.

[c] Impact on air quality is reduced 50% due to location, i.e., reported 727 tons x 0.5 = 364 tons.

[d] Emissions omitted from this analysis due to proximity to hi-vol site.

Table 6.4. FUGITIVE DUST WEIGHTING FACTOR

Site	Microinventory emissions, percent mineral	Glass fiber filters, percent mineral	Reduction ratio, $\frac{\text{Glass fiber}}{\text{Microinventory}}$	Millipore filters,[a] percent mineral	Reduction ratio,[a] $\frac{\text{Millipore}}{\text{Microinventory}}$
Henderson P.O.	96	70	0.73	61	0.64
Sahara	92	51	0.55	42	0.46
Sunrise	99	75	0.76	70	0.71
Average			0.68		0.60
Overall Average Reduction Ratio 0.64[b]					

[a] Ratio of percent mineralcollected on the hi-vol filter divided by the percent mineral emissions in the microinventory at the hi-vol site.

[b] For this study, the reduction ratio (weighing factor) was rounded to 0.60, as agreed to by the Clark County District Health Department.

in mineral emissions and reductions in ambient air quality are not expected to occur in a one-to-one ratio.

Since the control strategies described in Section 5 are applied to mineral emissions, only 60 percent of any reduction in emissions due to the control strategies will be observed in the ambient air quality as measured by the high-volume sampler. Therefore the weighting factor will be applied as follows:

Control strategy reduction, percent
times
Weighing factor, 0.60
equals
Effective percent reduction

Table 6.5 shows the effective reduction in emissions for each control strategy described in Section 5 due to the application of the 60 percent weighting factor. The effective percent reduction is then applied to each applicable emission category to generate the emissions that are input to the Hanna-Gifford model for strategy evaluation. This is as follows:

Affected category emissions (by grid)
times
effective percent reduction
equals
reduction in category emissions (by grid)

Total category emissions (by grid)
minus
reduction in category emissions (by grid)
equals
emissions input to control strategy evaluation.

For each source category which is affected by a control strategy, Tables 6.6 and 6.7 show the 1985 emissions by grid both before and after application of the control strategy. The reduction in emissions by grid due to the application of the strategy is also shown. Use of the factors shown in Table 6.5 for the development of Tables 6.6 and 6.7 is

Table 6.5. EFFECTIVE EMISSION REDUCTIONS
DUE TO CONTROL STRATEGY

Control strategy	Percent reduction	Weighting factor	Effective percent reduction
Street cleaning	25	0.6	15
Selected stationary source control:			
Point sources	85	0.6	51
Area sources	50	0.6	30
Railyard stabilization	80	0.6	48
Soil stabilization	80	0.6	48
Unpaved road chemical treatment	50	0.6	30

Table 6.6. 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR STREET CLEANING, SELECTED STATIONARY SOURCE CONTROL, AND RAILYARD STABILIZATION BY GRID

(tons/year)

Grid	Street cleaning			Selected stationary source control						Railyard stabilization		
	Normal paved streets			Industrial processes			Sand and gravel pit operations			Railroad right-of-ways		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
1												
2												
3	9.8	9.8								3.0	3.0	
4	8.9	8.9								2.5	2.5	
5												
6												
7	3.2	3.2										
8	13.5	13.5										
9										4.1	4.1	
10	2.2	2.2								3.8	3.8	
11	69.1	69.1								16.3	16.3	
12	10.5	10.5								1.2	1.2	
13	20.7	20.7										
14	10.8	10.8										
15	76.7	76.7								5.9	5.9	
16	7.3	7.3								5.2	5.2	
17										0.6	0.6	
18	4.4	4.4										
19												
20	16.9	16.9								1.8	1.8	
21	9.5	9.5										
22	11.7	11.7										
23	9.6	9.6										
										0.8	0.8	

Table 6.6 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR STREET CLEANING, SELECTED STATIONARY SOURCE CONTROL, AND RAILYARD STABILIZATION BY GRID

(tons/year)

Grid	Street cleaning			Selected stationary source control						Railyard stabilization		
	Normal paved streets			Industrial processes			Sand and gravel pit operations			Railroad right-of-ways		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
24	8.3	8.3								1.5	1.5	
25	4.7	4.7								1.5	1.5	
26	6.6	6.6								0.8	0.8	
27	6.8	6.8		165	86.5	78.5						
28	28.0	28.0		33	33.0					1.1	1.1	
29	74.0	74.0		321	260.6	60.4						
30	3.0	3.0										
31	1.4	1.4								0.9	0.9	
32	24.7	24.7								2.1	2.1	
33	8.6	8.6								1.8	1.8	
34	14.1	14.1								1.5	1.5	
35	19.8	19.8								0.9	0.9	
36	21.5	21.5										
37	17.4	17.4										
38	11.4	11.4										
39	9.9	9.9										
40	52.9	52.9		501	310.8	190.2	42	29.4	12.6			
41	0.8	0.8										
42	6.0	6.0								1.7	1.7	
43	55.8	55.8										
44	39.9	39.9										
45	17.7	17.7										
46	13.9	13.9										

Table 6.6 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR STREET CLEANING, SELECTED STATIONARY SOURCE CONTROL, AND RAILYARD STABILIZATION BY GRID

(tons/year)

Grid	Street cleaning			Selected stationary source control						Railyard stabilization		
	Normal paved streets			Industrial processes			Sand and gravel pit operations			Railroad right-of-ways		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
47	15.5	15.5										
48	10.1	10.1		158	158.0							
49	43.8	43.8										
50	2.3	2.3					59	41.3	17.7			
51	0.8	0.8										
52	24.2	24.2		1148	83.6	1064.4	529	370.3	158.7			
53	21.2	21.2										
54												
55	17.7	17.7										
56	50.1	49.7	0.4							1.7	1.7	
57	88.2	77.0	11.2									
58	49.4	43.6	5.8									
59	39.0	35.5	3.5									
60	31.0	31.0										
61	27.8	27.8										
62	66.3	63.1	3.2									
63	26.6	26.6										
64	18.4	18.4										
65	29.9	29.9										
66	78.9	78.2	0.7	7	0.0	7.0				0.8	0.8	
67	92.8	79.1	13.7							0.8	0.8	
68	36.2	30.8	5.4									
69	41.1	36.8	4.3									

Table 6.6 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR STREET CLEANING, SELECTED STATIONARY SOURCE CONTROL, AND RAILYARD STABILIZATION BY GRID

(tons/year)

Grid	Street cleaning			Selected stationary source control						Railyard stabilization		
	Normal paved streets			Industrial processes			Sand and gravel pit operations			Railroad right-of-ways		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
70	29.1	29.1										
71	59.2	52.9	6.3									
72	40.8	37.2	3.6									
73	11.4	11.4										
74												
75	0.9	0.9										
76	94.2	85.4	8.8									
77	40.0	39.4	0.6									
78	72.3	65.2	7.1									
79	122.3	110.5	11.8							3.0	3.0	
80	103.3	87.8	15.5									
81	85.9	78.2	8.7									
82	74.2	67.1	7.1									
83	63.0	60.5	2.5									
84	19.6	19.6										
85	10.0	10.0		1062	624.0	438.0	69	69.0				
86				158	77.4	80.6						
87												
88												
89	64.9	56.1	8.8									
90	55.7	47.3	8.4									
91	71.9	71.0	0.9	9	0.0	9.0				6.1	4.0	2.1
92	178.5	158.9	19.6							86.7	45.1	41.6

Table 6.6 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR STREET CLEANING, SELECTED STATIONARY SOURCE CONTROL, AND RAILYARD STABILIZATION BY GRID

(tons/year)

Grid	Street cleaning			Selected stationary source control						Railyard stabilization		
	Normal paved streets			Industrial processes			Sand and gravel pit operations			Railroad right-of-ways		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
93	137.0	123.1	13.9									
94	75.5	72.2	3.3									
95	41.3	39.2	2.1									
96	28.7	28.7										
97	7.0	7.0		39	20.1	18.9						
98	3.9	3.9										
99	102.6	102.6										
100	77.0	72.6	4.4									
101	112.9	101.2	11.7							1.0	0.0	1.0
102	203.0	191.4	11.6	6	0.0	-6.0	11	11.0		14.4	18.9	15.5
103	82.3	71.3	11.0									
104	42.2	35.9	6.3									
105	24.2	20.6	3.6									
106	24.7	21.4	3.3									
107	9.2	9.2										
108	5.5	5.5										
109												
110	117.1	112.5	4.6									
111	0.9	0.9										
112												
113	41.8	37.4	4.4									
114	60.7	51.6	9.1									
115	38.9	33.1	5.8									

Table 6.6 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR STREET CLEANING, SELECTED STATIONARY SOURCE CONTROL, AND RAILYARD STABILIZATION BY GRID

(tons/year)

Grid	Street cleaning			Selected stationary source control						Railyard stabilization		
	Normal paved streets			Industrial processes			Sand and gravel pit operations			Railroad right-of-ways		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
116	49.2	43.5	5.7									
117	78.8	67.0	11.8							1.5	1.5	
118	55.8	51.6	4.2									
119	20.3	19.7	0.6									
120	23.5	23.5										
121	10.3	10.3										
122	6.6	6.6										
123	41.1	38.0	3.1									
124	10.0	8.5	1.5									
125	30.5	25.9	4.6									
126	13.4	11.4	2.0									
127	69.3	64.5	4.8									
128	25.0	23.5	1.5							1.2	1.2	
129	21.0	21.0										
130	10.6	10.6										
131	5.0	5.0										
132												
133												
134	168.7	164.9	3.8									
135	73.0	62.1	10.9									
136	36.0	32.8	3.2									
137	120.4	120.4								1.8	1.8	
138	24.3	24.3					1	0.7	0.3	3.2	3.2	

Table 6.6 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR STREET CLEANING, SELECTED STATIONARY SOURCE CONTROL, AND RAILYARD STABILIZATION BY GRID

(tons/year)

Grid	Street cleaning			Selected stationary source control						Railyard stabilization		
	Normal paved streets			Industrial processes			Sand and gravel pit operations			Railroad right-of-ways		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
139												
140												
141	39.9	39.9										
142	75.1	75.1										
143	15.6	13.3	2.3									
144												
145				11	0.0	11.0				2.3	2.3	
146	5.0	5.0		22	10.8	11.2				4.4	4.4	
147	24.7	24.7								1.0	1.0	
148												
Tot.	5029.5	4716.5	313.0	3640.0	1664.8	1975.2	711.0	521.7	189.3	208.9	148.7	60.2

AND UNPAVED ROAD TREATMENT BY GRID

(tons/year)

Grid	Soil stabilization						Unpaved road treatment		
	Cleared areas			Natural surfaces			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions
1				72.4	72.4		121	121.0	
2				72.4	72.4		121	121.0	
3				65.6	65.6		48	48.0	
4				65.6	65.6		97	97.0	
5				36.7	36.7				
6				36.7	36.7				
7				65.6	65.6		97	97.0	
8				65.6	65.6				
9				65.6	65.6		218	218.0	
10				65.6	65.6		121	121.0	
11				65.6	65.6				
12				65.6	65.6		218	218.0	
13				65.6	65.6				
14	19.2	19.2		42.5	42.5				
15	56.3	56.3		36.7	36.7		82	82.0	
16				65.6	65.6		193	193.0	
17				72.4	72.4		193	193.0	
18				65.6	65.6		97	97.0	
19				11.6	11.6				
20				12.0	12.0				
21				2.3	2.3				
22				24.7	24.7				
23				18.5	18.5				

Table 6.7 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR SOIL STABILIZATION AND UNPAVED ROAD TREATMENT BY GRID

(tons/year)

Grid	Soil stabilization						Unpaved road treatment		
	Cleared areas			Natural surfaces			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions
24				49.4	49.4				
25				44.2	44.2				
26				21.8	21.8				
27				9.3	9.3				
28				2.9	2.9				
29				36.7	36.7		186	186.0	
30				36.7	36.7		97	97.0	
31				11.6	11.6				
32				38.0	38.0				
33	3.5	3.5		3.6	3.6				
34				14.7	14.7				
35				24.7	24.7				
36				18.5	18.5				
37				49.4	49.4				
38				39.8	39.8				
39				8.2	8.2				
40	19.2	19.2		2.3	2.3		17	17.0	
41				29.2	29.2				
42				26.3	26.3				
43	72.5	72.5		4.8	4.8		121	121.0	
44				4.8	4.8				
45				12.4	12.4				
46	149.0	149.0		37.1	37.1				

Table 6.7 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR SOIL STABILIZATION AND UNPAVED ROAD TREATMENT BY GRID

(tons/year)

Grid	Soil stabilization						Unpaved road treatment		
	Cleared areas			Natural surfaces			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions
47				37.1	37.1				
48				49.4	49.4				
49				19.3	19.3				
50				35.4	35.4		15	15.0	
51				72.4	72.4		363	363.0	
52	161.0	161.0		36.7	36.7		302	302.0	
53				114.9	114.9		218	218.0	
54				36.7	36.7		73	73.0	
55	41.0	41.0		38.8	38.8				
56	19.0	19.0		46.3	46.3				
57	22.6	11.8	10.8	4.9	2.5	2.4	10	7.0	3.0
58				19.5	10.1	9.4			
59	102.6	53.4	49.2	19.6	10.2	9.4			
60	102.6	53.4	49.2	18.5	9.6	8.9			
61				15.4	15.4				
62	105.9	105.9		30.9	30.9				
63				61.8	61.8				
64				61.8	61.8				
65				17.3	17.3				
66				15.9	15.9		12	12.0	
67	6.4	3.3	3.1	4.1	2.1	2.0			
68	13.7	7.1	6.6	5.2	2.7	2.5			
69				5.6	2.9	2.7			

Table 6.7 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR SOIL STABILIZATION AND UNPAVED ROAD TREATMENT BY GRID

(tons/year)

Grid	Soil stabilization						Unpaved road treatment		
	Cleared areas			Natural surfaces			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions
70	31.3	16.3	15.0	17.9	9.3	8.6			
71	59.0	59.0							
72				49.4	49.4				
73				61.8	61.8				
74				61.8	61.8				
75				72.4	72.4		169	169.0	
76	62.7	62.7		43.5	43.5		193	193.0	
77				6.9	6.9				
78	66.9	66.9		2.3	2.3				
79	31.5	16.4	15.1	7.6	4.0	3.6			
80	42.5	22.1	20.4	0.7	0.4	0.3			
81				7.4	3.8	3.6			
82	18.5	9.6	8.9	6.1	3.2	2.9	10	7.0	3.0
83				24.7	24.7				
84				49.4	49.4				
85	7.4	7.4		49.4	49.4				
86				55.6	55.6				
87				36.7	36.7		121	121.0	
88				36.7	36.7		24	24.0	
89				4.6	4.6				
90	96.6	96.6		2.3	2.3		19	19.0	
91	85.8	44.6	41.2	1.7	0.9	0.8	11	7.7	3.3
92				5.9	3.1	2.8	116	81.2	34.8

Table 6.7 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR SOIL STABILIZATION AND UNPAVED ROAD TREATMENT BY GRID

(tons/year)

Grid	Soil stabilization						Unpaved road treatment		
	Cleared areas			Natural surfaces			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions
93	29.0	15.1	13.9	0.5	0.3	0.2	24	16.8	7.2
94	24.8	12.9	11.9	20.6	10.7	9.9			
95	11.5	11.5		55.6	55.6				
96	27.5	27.5		49.4	49.4				
97				55.6	55.6				
98				15.4	15.4				
99				2.9	2.9				
100	5.5	5.5		4.6	4.6				
101	56.8	29.5	27.3	6.5	3.4	3.1	2	1.4	0.6
102	1.9	1.0	0.9	3.9	2.0	1.9			
103	25.3	13.2	12.1	5.8	3.0	2.8	72	50.4	21.6
104	9.8	5.1	4.7	15.8	8.2	7.6			
105				18.5	18.5				
106	52.7	52.7		46.3	46.3				
107				46.3	46.3				
108				5.9	5.9				
109				72.4	72.4		48	48.0	
110	120.0	120.0		57.9	57.9		268	268.0	
111				36.7	36.7		169	169.0	
112				36.7	36.7		97	97.0	
113				3.6	3.6				
114				5.9	5.9				
115				24.7	24.7				

Table 6.7 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR SOIL STABILIZATION AND UNPAVED ROAD TREATMENT BY GRID

(tons/year)

Grid	Soil stabilization						Unpaved road treatment		
	Cleared areas			Natural surfaces			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions
116	6.6	6.6		15.4	15.4	22	22.0		
117	73.0	73.0							
118				18.5	18.5				
119				46.3	46.3				
120				18.5	18.5				
121				36.8	36.8				
122				5.9	5.9				
123				11.7	11.7				
124				55.6	55.6				
125	45.1	45.1		49.4	49.4	5	5.0		
126				49.4	49.4				
127				18.5	18.5				
128				18.5	18.5				
129				30.9	30.9				
130				24.7	24.7				
131				28.6	28.6				
132				5.9	5.9				
133				72.4	72.4	290	290.0		
134				29.0	29.0	242	242.0		
135				60.8	60.8				
136				90.7	90.7				
137				55.0	55.0				
138	20.3	20.3		73.4	73.4				

Table 6.7 (continued). 1985 LAS VEGAS CONTROL STRATEGY EMISSIONS FOR SOIL STABILIZATION AND UNPAVED ROAD TREATMENT BY GRID

(tons/year)

Grid	Soil stabilization						Unpaved road treatment		
	Cleared areas			Natural surfaces			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions
139				51.2	51.2				
140				72.4	72.4				
141				65.6	65.6		97	97.0	
142				182.4	182.4		314	314.0	
143				136.1	136.1				
144				229.7	229.7		121	121.0	
145				72.4	72.4		73	73.0	
146				65.6	65.6		145	145.0	
147				65.6	65.6		73	73.0	
148				65.6	65.6		73	73.0	
Tot.	1906.5	1616.2	290.3	5473.2	5387.8	85.4	5818.0	5744.5	73.5

illustrated in the following examples.

Street cleaning - Fugitive dust from normal paved roads is one of the source categories affected by street cleaning. It was assumed that of the eight functional road classifications in Nevada - local street, minor arterial, major arterial, collector, ramp, interstate, freeway, and expressway - only the first four are subject to street cleaning. In grid 101, 69 percent of the total VMT is on these four road types. Therefore, 69 percent of the emissions are affected by street cleaning. Table 6.5 shows that cleaning will reduce emissions by 15 percent. Since emissions in 1985 are projected to be 112.9 tons/year in grid 101, the reduction in emissions due to street cleaning would be (112.9)(0.69)(0.15) = 11.7 tons/year. Emissions due to the application of the strategy are, therefore, 112.9 - 11.7 = 101.2 tons/year.

Note that the strategy of street cleaning is to be applied only within the city limits of North Las Vegas and Las Vegas, and an area south of the city to Tropicana Avenue between Interstate 15 and Eastern Avenue, and a stretch of Boulder Highway from East Sahara Avenue to Tropicana Avenue. Since grid 101 is entirely within the city limits, 100 percent of the emissions from the four specified road types is subject to control. However, this should be compared to grid 93. Although 75 percent of the emissions are from the four specified road types, only 90 percent of these occur within the boundaries of application of the control strategy. Thus, only 67 percent (75 x 0.90) of the emissions in grid 93 are affected by street cleaning rather than the full 75 percent. Since the 1985 emissions are projected to be 137.0 tons/year in grid 93, the reduction in emissions due to street cleaning would be (137.0)(0.67)(0.15) = 13.9 tons/year. Emissions due to the application of the strategy are, therefore, 137.0 - 13.9 = 123.1 tons/year.

Similarly, although grid 108 has emissions from the specified road types, none are within the control strategy boundaries of application, and, thus, are not subject to street cleaning. Therefore, no reduction in emissions due to this control strategy will be realized in grid 108.

Stationary source control - The two source categories affected by this strategy are industrial processes and sand and gravel pit operations. Industrial processes subject to control are screening and crushing operations associated with sand and gravel plants. Not included are concrete and asphalt batching, lime kilns, metal processing and refining, and combustion operations. It is estimated that baghouses can reduce point source emissions by an effective 51 percent, as shown in Table 6.5. For example, the projected 1985 industrial process emissions in grid 40 are 501 tons/year. However, only 373 tons/year are due to crushing and screening operations. Thus, the reduction in emissions is (373)(0.51) = 190.2 tons/year. The emissions due to the application of this strategy are, therefore, 501 - 190.2 = 310.8 tons/year. Note that grid 28, for example, has emissions in this source category, but these emissions are unaffected by the control strategy. This is because these emissions are entirely due to point source categories which have been excluded from this strategy.

The category of sand and gravel pit operations includes all area source processes associated with the sand and gravel industry. As shown in Table 6.5 watering is expected to reduce emissions from these sources by 30 percent. In grid 40 the projected 1985 emissions are 42 tons/year from active sand and gravel pit area sources. The reduction in emissions would be (42)(0.30) = 12.6 tons/year. The emissions due to the application of this strategy are, therefore, 42 - 12.6 = 29.4 tons/year. In grids 85 and 102 the sand and gravel pits are inactive and the control strategy will not be applied. Therefore, emissions in these grids will remain unchanged.

Railyard stabilization - The railyard located in grids 91, 92, 101, and 102 is the only source of emissions affected by this strategy. Stabilization will reduce emissions in these grids by 48 percent. In grid 92, where projected emissions are 86.7 tons/year, the reduction due to stabilization would be (86.7)(0.48) = 41.6 tons/year. The resultant emissions would be, therefore, 86.7 - 41.6 = 45.1 tons/year. Emissions from all grids other than 91, 92, 101, and 102 which have railroad right-of-ways will remain unchanged.

Soil stabilization - This control strategy affects all cleared areas and natural surfaces in only those grids within the outlined area shown in Figure 5.3. Stabilization is expected to reduce fugitive emissions from these sources by 48 percent. In grid 101 projected 1985 emissions from cleared areas and natural surfaces are 56.8 and 6.5 tons/year, respectively. The reduction in emissions would correspondingly be (56.8)(0.48) = 27.3 tons/year and (6.5)(0.48) = 3.1 tons/year. The emissions due to stabilization are, therefore, 56.8 - 27.3 = 29.5 tons/year and 6.5 - 3.1 = 3.4 tons/year, respectively.

Unpaved road treatment - The strategy of paving unpaved roads is also to be applied to the outlined area shown in Figure 5.3. By paving all unpaved roads within this area, emissions will be reduced by 30 percent, as shown in Table 6.5. In grid 101 projected 1985 emissions from unpaved roads are 2.0 tons/year. The reduction is (2.0)(0.30) = 0.6 tons/year, and the resultant emissions due to application of the strategy is 2.0 - 0.6 = 1.4 tons/year.

REFERENCES FOR SECTION 6

1. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task F Report, Particulate Characterization Study. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. August 1976.

2. Compilation of Air Pollutant Emission Factors. U.S Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. Publication No. AP-42. February 1976.

7. CONTROL STRATEGY RESULTS

Table 7.1 shows the projected 1985 TSP annualized air quality based on the projected inventory emissions. Next shown are the graphically-displayed reductions in air quality achieved by applying each control strategy to the 1985 uncontrolled emissions (Figures 7.1 through 7.5). The total reduction, due to the application of all control strategies, is shown in Figure 7.6.

According to the projected 1985 air quality, the area which will have difficulty meeting the primary National Ambient Air Quality Standards (NAAQS) of 75 $\mu g/m^3$ is an eight grid area (79, 80, 91, 92, 93, 101, 102, 103), concentrated in the central city. In these grids, the NAAQS are anticipated to be exceeded by up to 40 $\mu g/m^3$ in 1985. Even after the control strategies are applied, grids 92, 93, 102 and 103 are still expected to exceed the national standards by as much as 20 $\mu g/m^3$.

Other grids (40, 52, 85, 86), which are also shown to exceed the NAAQS, do so because of the impact of emissions from large local industrial sources. While control of these sources are not projected to reduce the local air quality to the level of the national standards, it will make a significant improvement.

The air quality in grid 62 is also shown to exceed the standards, primarily due to the emissions from cleared areas. However, the control strategy of soil stabilization did not include this area. Therefore, the air quality in this locality is expected to remain above the standards.

The same situation applies to grid 43 since the control strategy affecting emissions from unpaved roads, which is the main source in this grid, does not include this area.

Finally, the area in and around grid 48 is also shown by the model to slightly exceed the NAAQS. However, the major source of emissions in this grid is a power plant. Since the Hanna-Gifford model tends to over-predict sources such as this (emissions from a relatively tall stack) actual air quality in this grid is not expected to exceed the national standard in 1985.

The sources which are the major emitters in those grids which exceed the NAAQS are listed with their present contribution of total grid emissions in Table 7.2. In the first group in the table, at least 40 percent of the emissions in each grid are related to highway vehicles (normal streets and auto exhaust). In most of these grids, highway-vehicle-related sources contribute over 65 percent of the emissions. In the second group, excessive emissions are mainly due to localized industrial processes.

Table 7.1. LAS VEGAS CONTROL STRATEGY RESULTS AND REDUCTIONS, $\mu g/m^3$

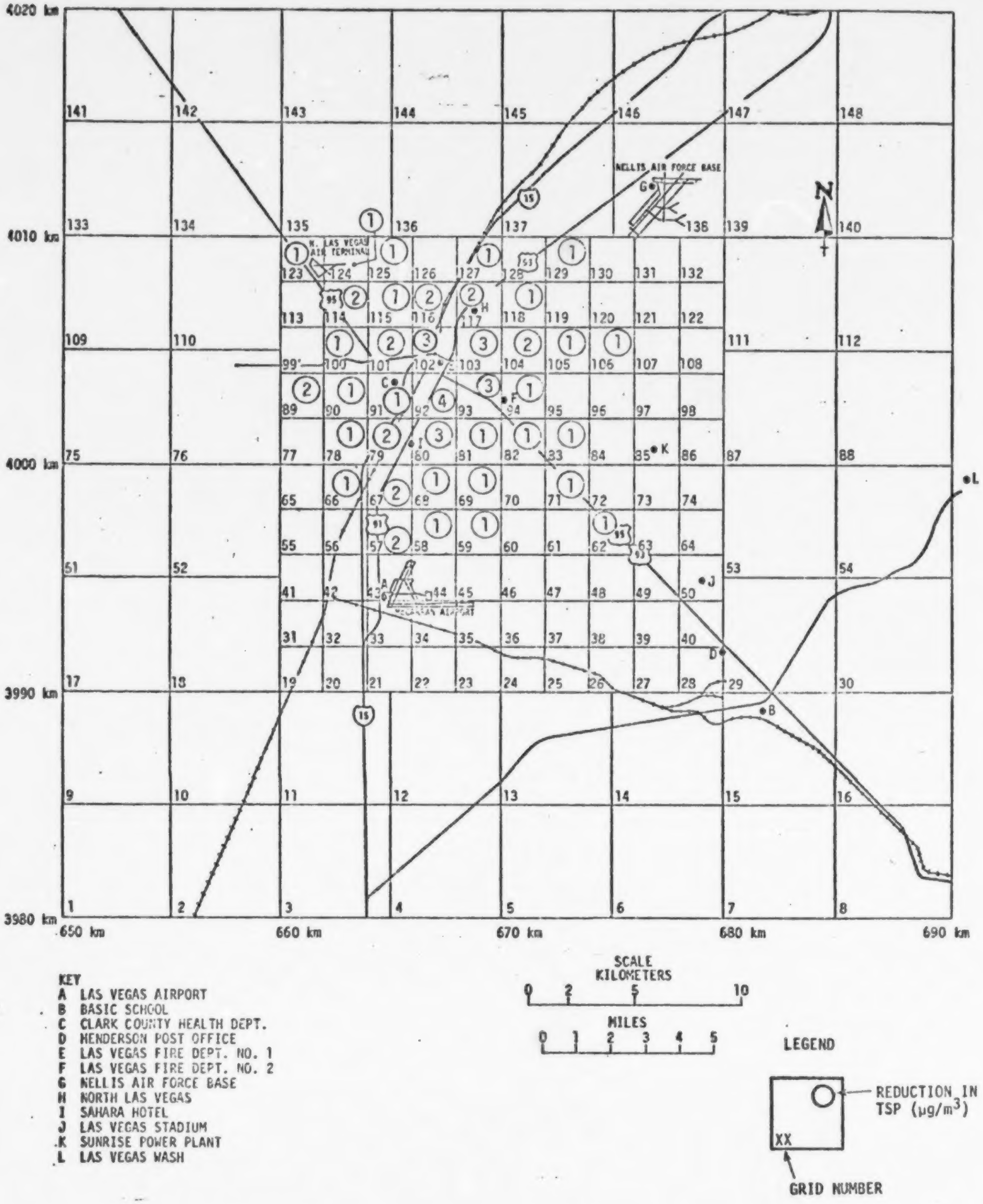
Grid	1985 Base	Street cleaning		Sel. Stationary source control		Railyard stabilization		Soil stabilization		Unpaved road treatment		All strategies applied	
	Modeled air quality	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy
1	44	44		44		44		44		44		44	
2	44	44		44		44		44		44		44	
3	42	42		42		42		42		42		42	
4	43	43		43		43		43		43		43	
5	39	39		39		39		39		39		39	
6	38	38		38		38		38		38		38	
7	42	42		42		42		42		42		42	
8	40	40		40		40		40		40		40	
9	48	48		48		48		48		48		48	
10	46	46		45	1	46		46		46		45	1
11	44	44		43	1	44		44		44		43	1
12	48	48		48		48		48		48		48	
13	42	42		42		42		42		42		42	
14	42	42		41	1	42		42		42		41	1
15	48	48		47	1	48		48		48		47	1
16	46	46		46		46		46		46		46	
17	49	49		49		49		49		49		49	
18	47	47		46	1	47		47		47		46	1
19	40	40		40		40		40		40		40	
20	44	44		44		44		44		44		44	
21	42	42		42		42		42		42		42	
22	45	45		45		45		45		45		45	
23	44	44		44		44		44		44		44	
24	49	49		49		49		49		49		49	
25	47	47		47		47		47		47		47	
26	45	45		44	1	45		45		45		44	1
27	69	69		56	13	69		69		69		56	13
28	54	54		53	1	54		54		54		53	1
29	60	60		59	1	60		60		60		59	1
30	44	44		44		44		44		44		44	
31	43	43		42	1	43		43		43		42	1
32	50	50		50		50		50		50		50	
33	45	45		45		45		45		45		45	
34	49	49		49		49		49		49		49	
35	50	50		50		50		50		50		50	
36	49	49		49		49		49		49		49	
37	54	54		53	1	54		54		54		53	1
38	50	50		49	1	50		50		50		49	1
39	47	47		44	2	46		46		47		44	2
40	142	142		111	31	142		142		142		111	31
41	48	48		46	2	48		48		48		46	2
42	47	47		47		47		47		47		47	
43	84	84		84		84		84		84		84	
44	53	53		53		53		53		53		53	
45	50	50		50		50		49	1	50		49	1
46	73	73		73		73		73		73		73	
47	55	55		55		55		54	1	55		54	1
48	76	76		76		76		76		76		76	
49	56	56		55	1	56		56		56		55	1
50	63	63		59	4	63		63		63		59	4
51	55	55		54	1	55		55		55		54	1
52	109	109		87	22	109		109		109		87	22
53	54	54		53	1	54		54		54		53	1
54	43	43		43		43		43		43		43	
55	64	64		61	3	64		64		64		61	3

Table 7.1 (continued). LAS VEGAS CONTROL STRATEGY RESULTS AND REDUCTIONS, µg/m^3

	1985 Base	Street cleaning		Sel. Stationary source control		Railyard stabilization		Soil stabilization		Unpaved road treatment		All strategies applied	
Grid	Modeled air quality	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy
56	63	63		62	1	63		63		63		62	1
57	65	63	2	65		65		63	2	65		61	4
58	60	59	1	60		60		58	2	60		57	3
59	71	70	1	71		71		61	10	71		60	11
60	71	71		71		71		62	9	71		62	9
61	57	57		57		57		57		57		57	
62	85	84	1	84	1	85		85		85		83	2
63	61	61		61		61		61		61		61	
64	57	57		56	1	57		57		57		56	1
65	60	60		57	3	60		60		60		57	3
66	67	66	1	66	1	67		67		67		65	2
67	65	63	2	65		65		64	1	65		62	3
68	57	56	1	57		57		55	2	57		54	3
69	57	56	1	57		57		55	2	57		54	3
70	59	59		59		59		54	5	59		54	5
71	67	66	1	66	1	67		66	1	67		64	3
72	66	66		64	2	66		66		66		64	2
73	73	73		71	2	73		73		73		71	2
74	56	56		54	2	56		56		56		54	2
75	48	48		48		48		48		48		48	
76	57	57		57		57		57		57		57	
77	61	61		59	2	61		61		61		59	2
78	72	71	1	71	1	72		72		72		70	2
79	80	78	2	80		80		77	3	80		75	5
80	75	72	3	75		75		71	4	74	1	67	8
81	65	64	1	65		65		64	1	65		63	2
82	66	65	1	66		66		64	2	66		63	3
83	63	62	1	62	1	63		62	1	63		60	3
84	61	61		59	2	61		61		61		59	2
85	238	238		172	66	238		238		238		172	66
86	85	85		69	16	85		85		85		69	16
87	48	48		47	1	48		48		48		47	1
88	42	42		41	1	42		42		42		41	1
89	60	68	2	59	1	60		60		60		57	3
90	75	74	1	75		75		75		75		74	1
91	83	82	1	82	1	82	1	76	7	82	1	72	11
92	115	111	4	115		108	7	113	2	109	6	96	19
93	84	81	3	84		84		81	3	83	1	77	7
94	69	68	1	69		69		65	4	69		64	5
95	69	69		69		69		69		69		69	
96	63	63		62	1	63		63		63		62	1
97	64	64		59	5	64		64		64		59	5
98	55	55		50	5	55		55		55		50	5
99	63	63		63		63		63		63		63	
100	61	60	1	61		61		61		61		60	1
101	79	77	2	79		79		74	5	79		72	7
102	100	97	3	100		97	3	98	2	99	1	91	9
103	85	82	3	85		84	1	82	3	81	4	74	11
104	64	62	2	64		63	1	61	3	63	1	57	7
105	54	53	1	54		54		54		54		53	1
106	63	62	1	62	1	63		63		63		61	2
107	52	52		51	1	52		52		52		51	1
108	44	44		43	1	44		44		44		43	1
109	44	44		44		44		44		44		44	
110	60	60		60		60		60		60		60	
111	48	48		47	1	48		48		48		47	1

Table 7.1 (continued). LAS VEGAS CONTROL STRATEGY RESULTS AND REDUCTIONS, μg/m^3

	1985 Base	Street cleaning		Sel. Stationary source control		Railyard stabilization		Soil stabilization		Unpaved road treatment		All strategies applied	
Grid	Modeled air quality	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy
112	43	43		42	1	43		43		43		42	1
113	52	52		52		52		52		52		52	
114	58	56	2	58		58		58		58		56	2
115	57	56	1	57		57		57		57		56	1
116	67	65	2	67		67		66	1	67		64	3
117	75	73	2	75		75		75		75		73	2
118	63	62	1	63		63		63		63		62	1
119	58	58		58		58		58		58		58	
120	52	52		52		52		52		52		52	
121	48	48		48		48		48		48		48	
122	41	41		41		41		41		41		41	
123	52	51	1	52		52		52		52		51	1
124	52	51	1	52		52		52		52		51	1
125	63	62	1	63		63		63		63		62	1
126	53	53		53		53		53		53		53	
127	62	61	1	62		62		62		62		61	1
128	51	51		51		51		51		51		51	
129	50	49	1	50		50		50		50		49	1
130	47	47		47		47		47		47		47	
131	48	48		48		48		48		48		48	
132	39	39		39		39		39		39		39	
133	50	50		50		50		50		50		50	
134	55	55		55		55		55		55		55	
135	46	46		46		46		46		46		46	
136	46	46		46		46		46		46		46	
137	48	48		48		46		48		48		48	
138	45	45		45		45		45		45		45	
139	40	40		40		40		40		40		40	
140	40	40		40		40		40		40		40	
141	46	46		46		46		46		46		46	
142	58	58		58		58		58		58		58	
143	45	45		45		45		45		45		45	
144	50	50		50		50		50		50		50	
145	44	44		44		44		44		44		44	
146	46	46		46		46		46		46		46	
147	43	43		43		43		43		43		43	
148	41	41		41		41		41		41		41	



4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
N. LAS VEGAS AIR TERMINAL
NELLIS AIR FORCE BASE
LAS VEGAS AIRPORT
N
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER

KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH

Figure 7.1 Change in 1985 Las Vegas air quality due to street cleaning.

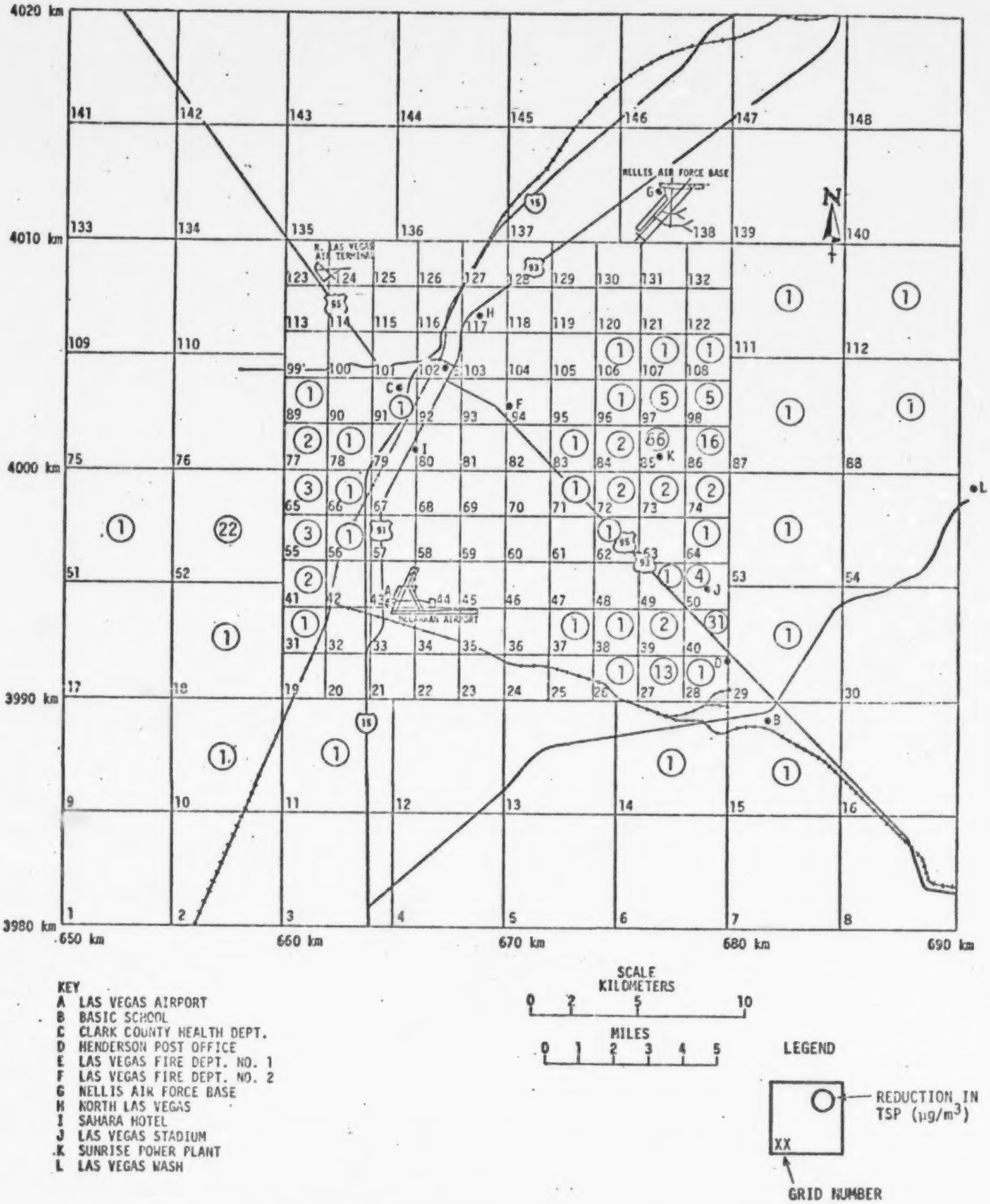

4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
N
NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
MCCARRAN AIRPORT
KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER

Figure 7.2 Change in 1985 Las Vegas air quality due to control of selected stationary sources.

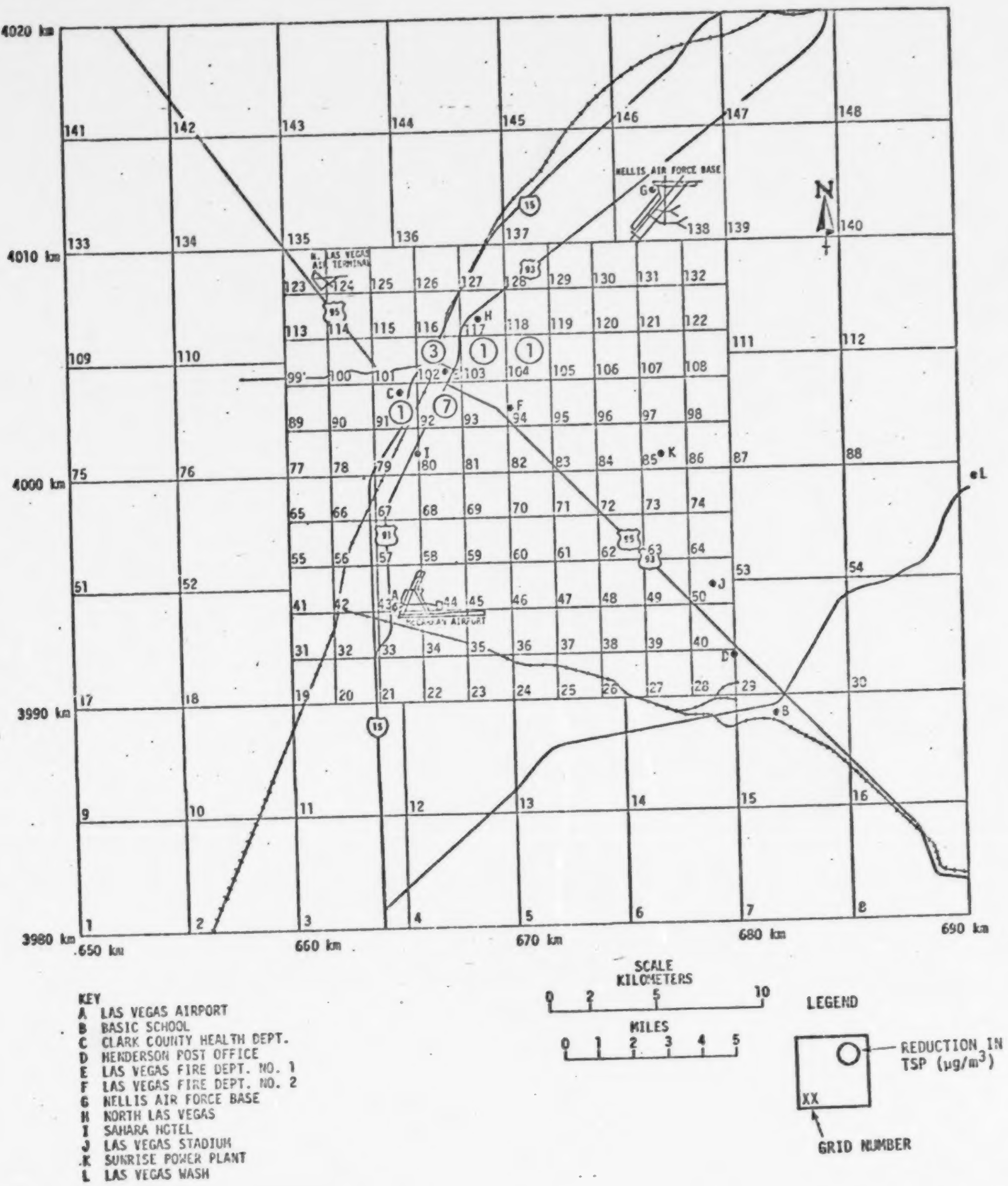
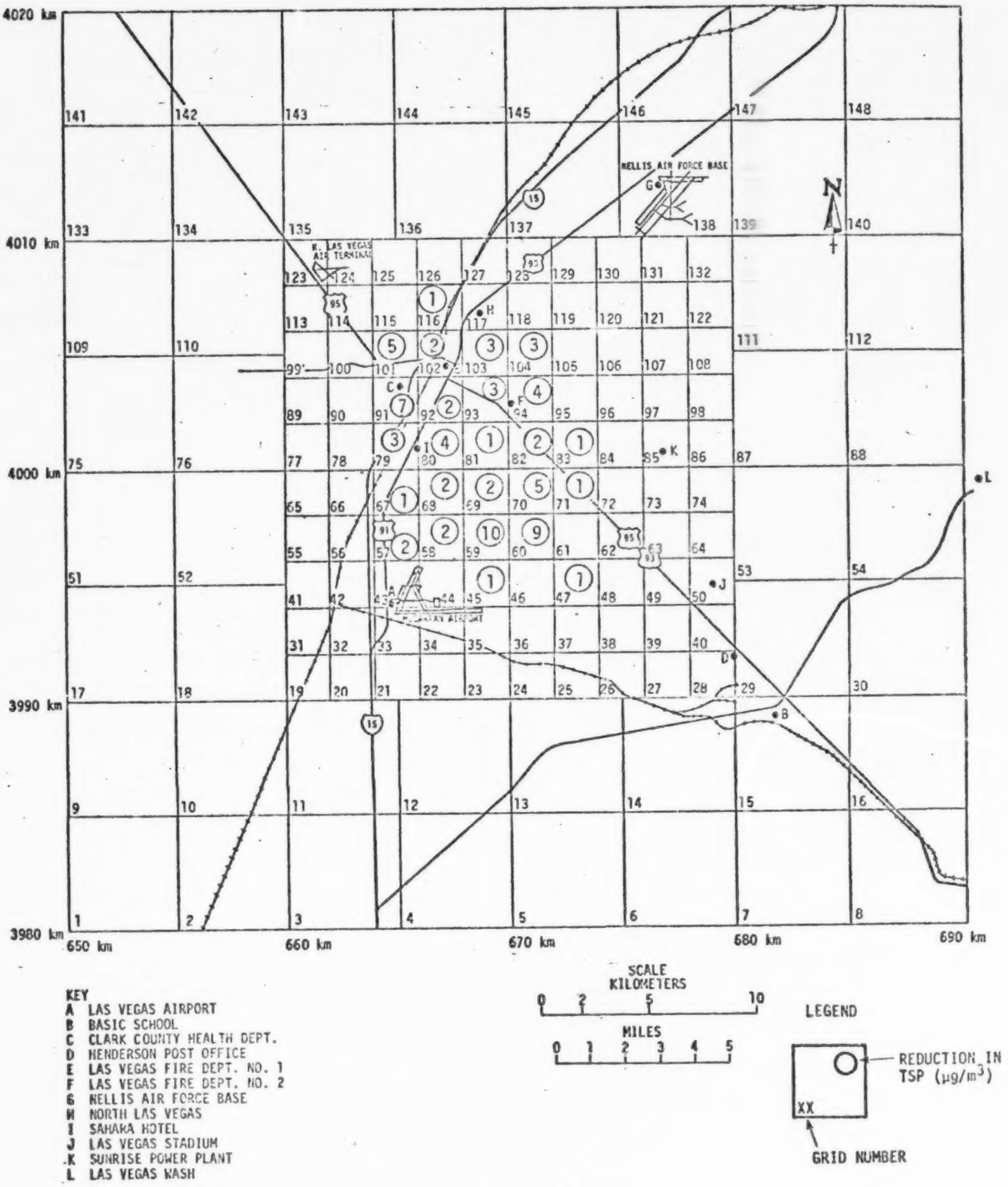

4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
McCARRAN AIRPORT
N
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER
③
①
①
①
⑦

Figure 7.3 Change in 1985 Las Vegas air quality due to railyard stabilization.



4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
McCARRAN AIRPORT
N
KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
LEGEND
REDUCTION IN TSP ($\mu g/m^3$)
XX
GRID NUMBER

Figure 7.4 Change in 1985 Las Vegas air quality due to soil stabilization.

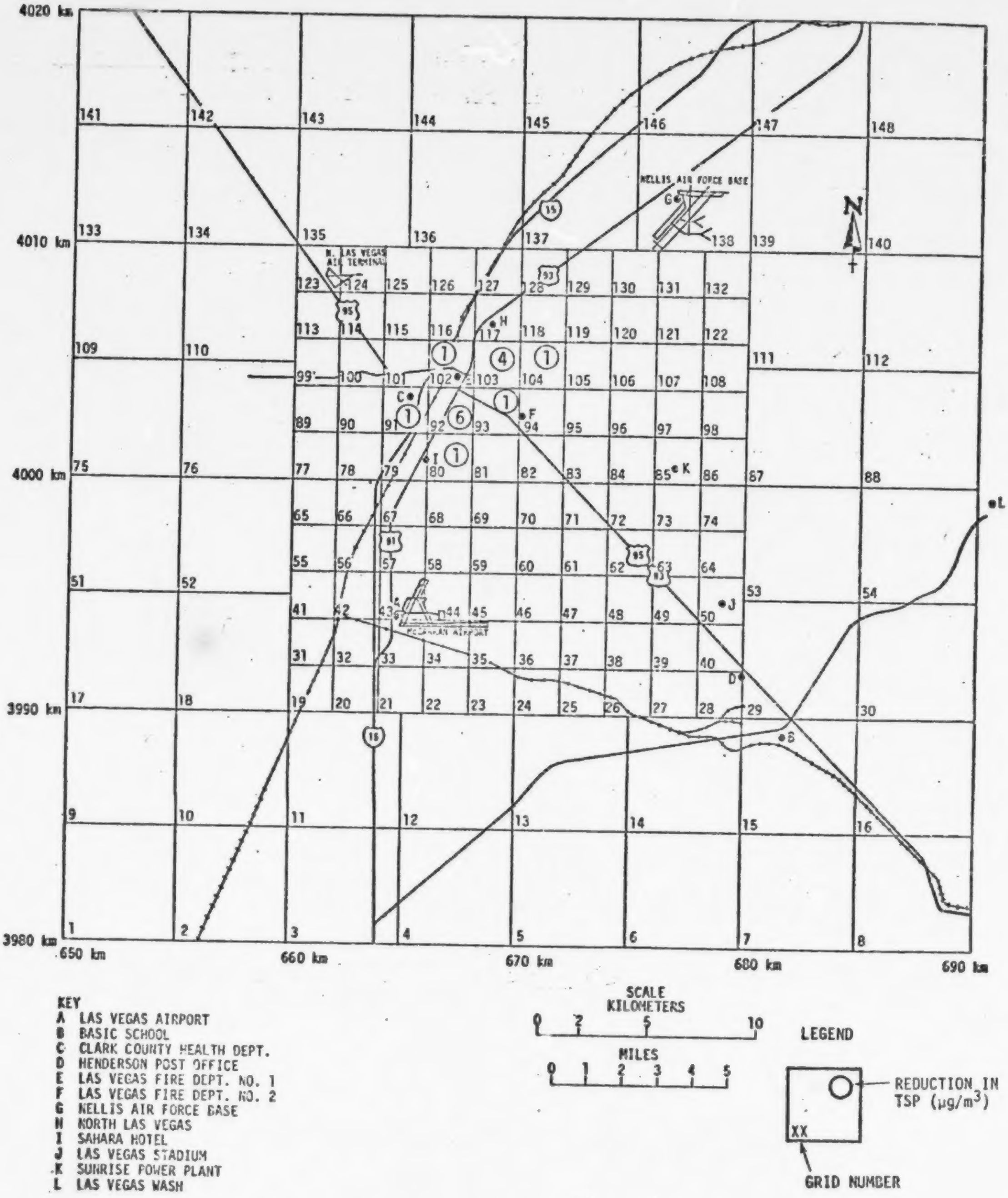

4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
N
NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
MCCARRAN AIRPORT
KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER

Figure 7.5 Change in 1985 Las Vegas air quality due to unpaved road chemical treatment.

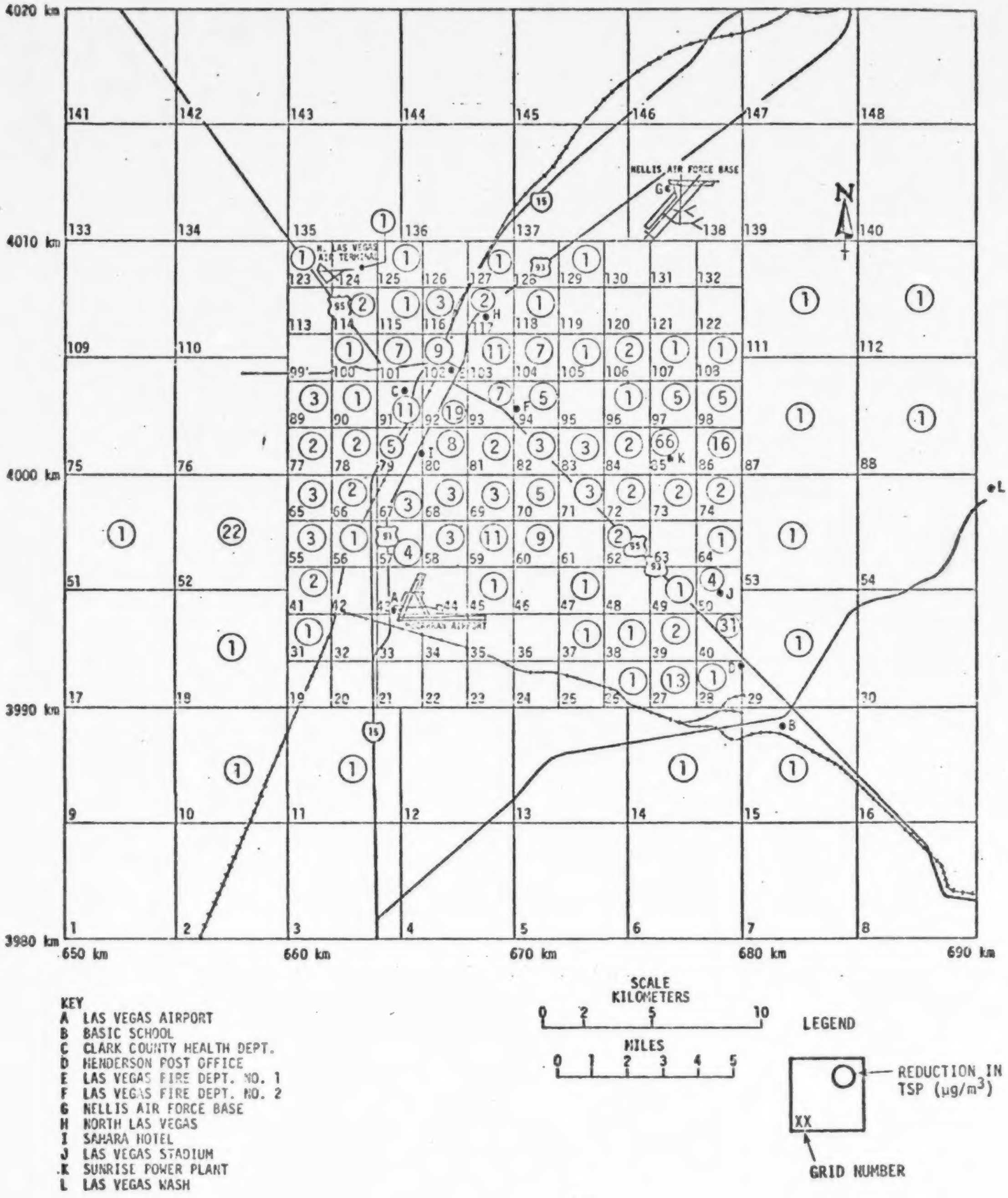

4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
McCARRAN AIRPORT
N
KEY
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5
LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER

Figure 7.6 Total change in 1985 Las Vegas air quality due to all control strategies.

Table 7.2 SOURCE CONTRIBUTION TABLE FOR GRIDS EXCEEDING NAAQS

Grid exceeding standard	Major contributing sources (percent contribution of total grid emissions)
79	normal streets (57), cleared areas (14), auto exhaust (12)
80	normal streets (57), cleared areas (23), auto exhaust (12)
91	cleared areas (38), normal streets (32), auto exhaust (7), unpaved roads (5)
92	normal streets (41), unpaved roads (27), railyards (20)
93	normal streets (59), auto exhaust (13), cleared areas (12), unpaved roads (10)
101	normal streets (54), cleared areas (27), auto exhaust (12)
102	normal streets (61), auto exhaust (13), railyards (11)
103	normal streets (37), unpaved roads (32), cleared areas (12), auto exhaust (8)
40	industrial processes (75), normal streets (8)
43	unpaved roads (42), cleared areas (25), normal streets (19)
48	industrial process (90)
52	industrial processes (52), sand and gravel (24), unpaved roads (14)
62	cleared areas (45), normal streets (28)
85	industrial processes (85)
86	industrial processes (99)

8. REGULATORY CONSIDERATIONS

In dealing with TSP non-attainment situations, two sources of fugitive particulate emissions must be considered in conjunction with the relatively well-defined particulate loadings emitted from process stacks and vents. These sources of fugitive particulates can be classified as either "fugitive emissions" or "fugitive dust." Ideally, a fugitive particulate regulation should be applicable to both source categories and control both types of emissions. Fugitive emissions may be generally defined as including those that result from industrial related operations and which escape to the atmosphere through windows, doors, leaks, etc.; not through a primary exhaust system, such as a stack, flue, or control system." For most purposes fugitive dusts are generally related to natural or man-associated particulates that become airborne due to the forces of wind, man's activity, or both.

Presently there are four general regulatory approaches that have been used to control either or both types of fugitive particulates:

- Nuisance Provisions
- Opacity Limitations
- Performance Standards
- Air Quality Measurements, in terms of total suspended particulates.

Nuisance provisions are based upon traditional concepts of "unreasonable interferences with the rights of others", and necessarily depend upon the subjective opinions of a number of citizens as to the harm being caused them by some source.

Opacity limitations relate to the optical properties of emitted particulate matter and assume that there is a meaningful relationship between the light obscuring properties of the particulate matter emitted by a fugitive dust or fugitive emission source and the mass per unit time of particulate matter emitted by such a source. Implied in such a concept is the assumption that there is a similar relationship between opacity and ambient concentrations of particulate matter.

Performance standards are specifications as to the ways certain fugitive particulate sources should be constructed or operated. This concept evolves from the fact that there are no well-established or standard ways to measure the amount of dust being emitted by most fugitive sources, hence no way to establish quantitative emission standards for those sources. As a result, the concept suggests that ways of controlling emissions should be specified rather than allowable amounts of emissions.

Air quality measurements assess the impact of the fugitive particulate source's emissions upon air quality. They can be measured either with dustfall jars for settleable particulates, high volume samplers for suspended particulates, or paper tape samplers for the soiling properties of the emitted dust. Where high volume samplers are used, the source's impact can be directly related to the NAAQS.

Selecting which of these approaches is preferable for incorporation in a regulation is not a simple task. All have drawbacks and merits relative to each other. The end result is that no one approach is clearly preferable.

The remainder of this section is devoted to a discussion of factors/approaches pertinent to specific control options considered in this report.

STREET CLEANING

There are three basic types of street sweepers in use today: mechanical broom, regenerative air, and vacuum. Street flushers also are used in some areas. The broom sweeper moves material from the gutter into the main pickup broom which rotates to carry the material onto a belt and into the hopper. The regenerative air system blasts the dirt and debris from the road surface into the hopper with a portion of the air being recycled. Vacuum sweepers use both a broom for loosening and moving street dirt debris and a vacuum system to pick up the debris. Street flushers use sprayed water to displace dirt and debris from the street surface to the gutter. The volume of water used is normally insufficient to transport the accumulated debris to the nearest drain.

In general, what little literature is available suggests that flushers provide little air pollution control benefit. Broom sweepers will collect in excess of 50 percent of the debris loading, but tend to produce more respirable range particles and spread the debris more uniformly across the road. One operational limitation which makes its use alone in reducing reentrained dust of doubtful value is that it is not efficient in removing fine particles. Regenerative air sweepers tend to remove material at lower efficiencies (approximately 40 percent) and produce the same adverse impacts as do the broom sweepers. Vacuum sweepers seem to collect material at much higher collection efficiencies without the adverse impacts associated with the other two types.

The current street cleaning program in Las Vegas involves 13 broom-type cleaners operating on a 7-day cycle at an annual cost of $732 per curb-mile. In North Las Vegas 1 vacuum-type and 2 broom-type cleaners operate on a 7-day cycle at a cost of $506 per curb-mile. Clark County operates its 6 broom-type cleaners on an 8.5-day cycle for $210 per curb-mile. In this area the total annual cost of street cleaning is:

Las Vegas
($732/curb-mile/yr)(700 curb-miles) = $512,400
N. Las Vegas
($506/curb-mile/yr)(247 curb-miles) = $124,982
Clark Co.
($210/curb-mile/yr)(111 curb-miles) = $ 23,310
Total annual cost = $660,692

Note that these costs include capital, operation, maintenance and labor.

For the implementation of the proposed control strategy, the capital cost of 8 new vacuum-type cleaners is $360,000, while the operating and maintenance costs for these cleaners is $200,000 annually.

The most feasible way to implement this control strategy would be for the Clark County APCD to enter into an "Administrative Agreement" with its appropriate counterpart in the County Government. Items of major importance in such an agreement include:

- Specification of the type and number of street cleaning units and ancillary equipment required, along with a schedule for their acquisition.
- Specification of the skill requirements for and number of personnel required, along with a schedule for their hiring.

- Specific designation of the street boundaries to be cleaned, along with a schedule for cleaning operations based on a minimum required frequency.
- The required funding plan, showing how and when these monetary needs will be included as "line items" in proposed Clark County budget allocations.
- A mechanism for periodic intra-agency review of program status progress in light of air quality measurement evaluations, i.e., attainment and maintenance of NAAQS.

Inherent in any such "Administrative Agreement" should be the flexibility to allow modifications and/or changes to the agreement which may be required as the program progresses. More detail on improving street cleaning through the implementation of such an administrative agreement is given in Appendix B.

STATIONARY SOURCE CONTROL

Section 41 (Fugitive Dust), Air Pollution Control Regulations, District Board of Health of Clark County, generally covers control of the sources of fugitive particulates identified in this AQCR. However, consideration of the following modifications or incorporations to the existing regulation may make it more definitive and perhaps easier to enforce:

- Incorporation of a "Standard of Compliance" section, utilizing equivalent opacity observations at specific locations, (Colorado, North Dakota, for example) or, upwind-downwind TSP concentration limits over short-term time averaging periods (i.e., 1-8 hours) at locations adjacent to the source as specified by the agency (Texas, for example).

- Incorporation of a "Reasonable Precautions Required" section, which would expand the present regulation by indicating reasonable control techniques available for prevention of particulate emissions from becoming airborne, as illustrated by the following examples:

  Crushing, screening, handling, conveying, or processing materials:
  (1) installating hoods, fans, and exhaust systems to enclose and vent the processing of dirty materials
  (2) covering conveyance systems
  (3) enclosing aggregate storage piles, or reducing the amount of vehicular or aggregate movement on open storage piles
  (4) moisturizing or chemically treating the material during processing
  (5) sealing leaks or openings in process enclosures

CONTROL OF EMISSIONS FROM CLEARED AREAS

Section 41, especially part 41.1.2 of the existing regulations, is adequate for control of cleared areas such as the railroad yards and other "lots" scattered throughout the region. For comparison purposes, the Pima County (Tucson, Arizona) Rule 2-F covers this source category as follows:

> "No person shall cause or permit a vacant lot, or an urban or suburban open area, to be driven over or used by motor vehicles, trucks, cars, cycles, bikes, or buggies, or by animals (as horses), without taking precautions to limit dust from becoming airborne. Dust shall be kept to a minimum by using an approved suppressant, or adhesive soil stabilizier, or by paving, or by barring access to the property, or by other acceptable means."

CONTROL OF CONSTRUCTION EMISSIONS

Section 41, especially part 41.1.1 of the existing regulations, is adequate for control of construction activity emissions.

REDUCTION OF UNPAVED ROAD EMISSIONS

As with street cleaning, the most practical approach to implementation of this control strategy is through an "Administrative Agreement" between the Clark County APCD and the appropriate county entity. Items of major importance in such an agreement include:

- Specifications of the type of paving or treatment of the roadway, most probably based on average daily traffic volume. As a general rule, an ADTV of more than 150 vehicles dictates a quality of paving equal to or better than a 3" bituminous surface or equivalent.

- Specific designation of the roads to be paved or treated, along with a schedule for pavement/treatment based on frequency of use.

- Provisionof maintenance and repair services and materialson an "as needed" basis.

- Provisionfor establishment and enforcement of speed limts on roads which will remain unpaved, based upo proximity to concentrations of human populatio.

- The requied funding plan, showing how and when these montary needs will be included as "line items" improposed Clark County budget allocations.

Inherent in an such "Administrative Agreement" should be the flexibility o allow modifications and/or changes to the agreement whichmay be required as the program progresses.

APPENDIX A. CHEMICAL DUST SUPPRESSANTS, THEIR COST, USES, AND APPLICATION RATES[a]

Company/address phone/contact	Product name/ product type	Cost	Uses/comments	Density, dilution and application rates
Dow Chemical Co. 2020 Dow Center Midland, Mich. [illegible] Mr. Harold Filter	XFS - 4163L Styrene-Butadiene	55 gallon drums 1 drum - $2.65/gal 25 drums - $2.15/gal Bulk - $1.90/gal	Mulches such as straw, wood cellulose fiber, and fiberglass. Used to prevent wind loss of mulches during stabilization periods such as reseeding periods.	8.5 lbs/gal. 40 gallons XFS - 4163L: 360 gallons water 400 gallons/acre
Witco Chemical Corp. Golden Bear Division Post Office Box 378 Bakersfield, Calif. 93302 [illegible] Mr. William Coleman	Coherex Cold water emulsion of Petroleum Resins	55 gallon drums 1-10 drums - $0.65/gal >10 drums - $0.63/gal Bulk - $0.38/gal	Unpaved haul roads and stockpiles. Can be used around human or animal habitats - very clean - no heat required. Can be stored for 12 months or longer. Must be protected from freezing - unless freeze stable type is used. Can be spread through any type of equipment used to spread water.	8.33 lb/gal. 1:4 dilution, 1-1.5 gal/yd^2 for parking lots and dirt roads. 1:7 dilution 0.5 to 1 gal/yd^2 for thin layer or loose dirt, light traffic, service roads. 1:10 dilution for aid in packing surface
	Semi-pave Cold asphalt cutback with antistrip agent	55 gallon drums 1-10 drums - $0.68/gal >10 drums - $0.64/gal Bulk - $0.39/gal	Penetration of unpaved areas - low traffic volume roads - parking lots etc. Can be handled without heat if ambient temperature is 50°F or higher.	250 gallons/ton 0.6 to 0.8 gal/yd^2
American Cyanamid Wayne, New Jersey 07470 [illegible] Mr. L. E. Randolph	Aerospray 52 binder	55 gallon drums 1-4 drums - $0.69/lb 5-11 drums - $0.66/lb 12-22 drums - $0.63/lb 23-53 drums - $0.61/lb >53 drums - $0.59/lb Bulk - $0.55/lb	Seed membrane protection, excavation, construction, slope stabilization	8.8 lb/gallon 2:1 1 gallon/100 ft^2

[a] Mention of company or product names is not to be considered as an endorsement by the U.S. Environmental Protection Agency.

APPENDIX A (continued). CHEMICAL DUST SUPPRESSANTS, THEIR COST, USES, AND APPLICATION RATES[a]

Company/address phone/contact	Product name/ product type	Cost	Uses/comments	Density, dilution and application rates
E. F. Houghton & Co. Valley Forge Tech. Center Madison & Van Buren Ave. Norristown, PA [illegible] 215-[illegible] Mr. [illegible] Sutcliffe	Surfax 5107	55 gallon drums 1-4 drums - $4.44/gal 5-9 drums - $4.41/gal 10-39 drums - $4.38/gal >39 drums - $4.35/gal	Coal loading, quarries, cement plants, crushers, sintering plants.	8.5 lb/gallon 1:1000 or higher
	[illegible] 5411-B Polymer	55 gallon drums 1-4 drums - $0.415/lb 5-9 drums - $0.41/lb 10-39 drums - $0.405/lb >39 drums - $0.40/lb	Storage piles, railcars, road sides.	8.75 lb/gal 1:30 40 gal/1000 ft^2, recommended 2 applications
Monsanto 800 N. Lindbergh Blvd. St. Louis, MO 63166 314-[illegible] Mr. [illegible] A. Cooper	Gelvatol 20-90 Polyvinyl alcohol resin	50 lb/bags 500 lb - $0.905/lb 2,000 lb - $0.80/lb 10,000 lb - $0.77/lb 30,000 lb - $0.74/lb >30,000 lb - <$0.725/lb	Surfactant and protective colloid in emulsion polymerization.	30-40 lbs/ft^3 10 to 20 percent by weight
	Gelva Emulsion S-55 Polyvinyl acetate homopolymer	55 gallon drums 1-3 drums - $0.27/lb 4-19 drums - $0.26/lb >19 drums - $0.25/lb Bulk - $0.205/lb	Adhesives	500 lb/55 gallon drum 1% by weight
Air Products & Chemicals, Inc. 5 [illegible] Swedesford Road Wayne, PA 19087	Vinol 540 Polymer (water soluble)	50 lb bags 500 lb - $0.80/lb 2,000 lb - $0.77/lb 10,000 lb - $0.74/lb 32,000 lb - $0.725/lb 120,000 lb - $0.72/lb	Two grades: 1) soluble in water (washed away with rain), 2) relatively insoluble in water.	1 to 7 percent by weight Slurried in cold water or heated to insure complete mixture in solution
Union Carbide Corp. [illegible] & Madisonville Rd Cincinnati, Ohio 45227 513-[illegible] Mr. [illegible] Brown	DCA-70		Stabilize steep grades, tailings ponds. Not for vegetation growth.	9.25 lb/gal 2:1

[a] Mention of company or product names is not to be considered as an endorsement by the U.S. Environmental Protection Agency.

APPENDIX A (continued). CHEMICAL DUST SUPPRESSANTS, THEIR COST, USES, AND APPLICATION RATES[a]

Company/address phone/contact	Product name/ product type	Cost	Uses/comments	Density, dilution and application rates
Enzymatic Soil of Tucson [illegible] W. Los Arbolas Ct. Tucson, Arizona 85704 [illegible] Mr. Bob Mundell	Enzymatic SS	55 gallon drums $7.60/gallon	Hold down dust on haul roads, tailings, stock pile. Will retard growth of weeds or plants. Seal lakes, stock tanks, stabilize odors around stock pens.	8.34 lb/gal 1:1000 1000 gallon/20 to 30 yd^3
Asphalt Suppressions Corp. [illegible] E. Colorado Blvd. Denver, Colorado [illegible] [illegible] Mr. [illegible]	Pennprime Low-viscosity, special hard-base asphalt cut-back	10,000 gal lots $0.45/gal	Control of wind, rain, or water erosion of soils. Applied to roads and streets to allay dust and stabilize surface to carry traffic. Does not allow seed germination. Very light applications (0.2-0.4 G.S.Y. may accelerate seed germination due to warming of black surface. Applications above 0.4 G.S.Y. inhibit plant growths through hardness and toughness of the crust formed. Plant growths through the crust may be further inhibited by addition of several oil-soluble sterilants. Sterilants kill plant as it emerges. The material may be applied at temperatures as low as 75°F by conventional asphalt distribution equipment.	0.85 S.G. dust abatement - 0.2 gal/yd^2 erosion control - 0.5-1.0 gal/yd^2

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[a] Mention of company or product names is not to be considered as an endorsement by the U.S. Environmental Protection Agency.

			pens.	
Asphalt Rubberizing Corp. 1111 E. Colorado Blvd. Denver, Colorado 80222 303-756-3012 Mr. [illegible]	Peneprime Low-viscosity, special hard-base asphalt cut-back	10,000 gal lots $0.45/gal	Control of wind, rain, or water erosion of soils. Applied to roads and streets to allay dust and stabilize surface to carry traffic. Does not allow seed germination. Very light applications (0.2-0.4 G.S.Y. may accelerate seed germination due to warming of black surface. Applications above 0.4 G.S.Y. inhibit plant growths through hardness and toughness of the crust formed. Plant growths through the crust may be further inhibited by addition of several oil-soluble sterilants. Sterilants kill plant as it emerges. The material may be applied at temperatures as low as 75°F by conventional asphalt distribution equipment.	0.85 S.G. dust abatement - 0.2 gal/yd^2 erosion control - 0.5-1.0 gal/yd^2

* Mention of company or product names is not to be considered as an endorsement by the U.S. Environmental Protection Agency.

		10-44 drums - $3.30/gal >44 drums - $3.20/gal		Application lasts 1 to 5 years
	Coal Tarp	$0.75-$1.00/gal	Designed for use in coal industry: coating over rail cars, trucks to prevent transportation losses etc. Prevents seed germination.	
Grass Growers P. O. Box 584 Plainfield, NJ 07061 201-755-[illegible] Mr. [illegible]	Tarratack-1	$2.25/lb	Mulch binder used for stabilizing any type of grass to be grown.	5 lb: 250 gal water, mixed with wood fiber mulch (40 lb/acre) 5 lb: 150 gal water, mixed with hay or straw (40 lb/acre)
	Tarratack-2	$2.75/lb	Same as Tarratack-1	Mixed with hay or straw 40 lb/acre
	Tarratack-3	$3.25/lb	Same as Tarratack-1	Mixed with wood fiber only

* Mention of company or product names is not to be considered as an endorsement by the U.S. Environmental Protection Agency.

APPENDIX A (continued). CHEMICAL DUST SUPPRESSANTS, THEIR COST, USES, AND APPLICATION RATES[a]

Company/address phone/contact	Product name/ product type	Cost	Uses/comments	Density, dilution and application rates
Dubois Chemical Dubois Tower Cincinnati, Ohio 513-762-6000 Mr. Burgee	Floculite 600	100 lb - $2.81/lb 1000 lb - $2.74/lb	Used in waste water treatment from mines. Also helps keep down dust on haul roads.	1-2 lb/1000 gal
Mona Industries, Inc. 65 E. 23rd St. Paterson, NJ 07524 201-274-6220 Mr. George Lowry	Monawet Mo-70E	500 lb drums 1-50 drums - $0.455/lb Bulk - $0.385/lb	Used in coal industry as dust suppresant	0.1 percent in water, must be reapplied when water evaporates
AMSCO Division Union Oil Company of California 14445 Alondra Blvd. La Mirada, Calif. 90638 714-523-5120 Dr. Ralph H. Bauer	Res AD 1081 Styrene Butadiene		Soil stabilizer particularly in conjunction with wood fiber malches. Free pumping in conventional hydroseeding equipment. Not to be applied in soils with pH less than 6.0.	8.2 ± 0.1 lb/gallon

[a] Mention of company or product names is not to be considered as an endorsement by the U.S. Environmental Protection Agency.

APPENDIX B

PROGRAMS FOR IMPROVED STREET CLEANING[1]

THE CONCEPT OF AN ADMINISTRATIVE AGREEMENT

Regulations requiring municipalities to adopt specific street cleaning practices for air pollution control purposes would probably be unsuccessful, principally because present knowledge of controls for reentrained dust is insufficient to define general regulatory terms which outline the optimum street cleaning program for a city. As an alternative to regulation, the use of an administrative agreement between the air pollution control agency and the local government is proposed. Through this agreement, the local government would be committed to institute changes in street cleaning practices in order to improve particulate air quality.

The term "administrative agreement" as used herein refers to a written agreement entered into by two or more governmental units. Such an agreement would constitute a formal, but not necessarily legally enforceable, commitment by one governmental unit to engage in a specific set of activities. It would consist of a statement of local governmental policy regarding street cleaning and air pollution control and a plan by that body to implement programs, including any necessary budgetary adjustments. A timetable for implementing the actions would also be specified in the written agreement. An example of this type of agreement is presented in Figure B-1.

This AGREEMENT made and entered into on this the ________ day of ______, 19__, by and between the STATE of _______, hereinafter referred to as the Party of the First Part, and the CITY Of _______ _______, a municipal corporation organized and existing under and by virtue of the laws of the State of ________, hereinafter referred to as the Party of the Second Part.

WITNESSETH:

That, WHEREAS, the parties hereto recognize that there is a great need on the part of their citizens for a program and/or system for controlling dust from paved streets and parking facilities affecting air quality within the jurisdictions of the party of the first part and the party of the second part; and

WHEREAS, the party of the first part has found that the institution of a program and/or system for controlling air pollution from paved surfaces is necessary in order to achieve the intents and puposes of the State Air Pollution Control Implementation Plan; and

WHEREAS, the party of the second part is desirous and willing to define and implement policies and execute programs which will produce effective control of dust from paved surfaces owned and operated by the party of the second part.

NOW, THEREFORE, in cosideration of the premises and in the further consideration of the mutual agreements and covenants hereinafter contained, the parties hereby enter into the following agreements:

1. The party of thesecond part is authorized by the party of the first part to carry out those portions of the State Air Pollution Control Implementation Plan relating to control of dust from pavd streets within its jurisdiction.

2. It is agreed tha the party of the first part, acting through its Department of Environmental Protectio, will provide technical assistance to the party of the second part in defining the degre and extent of fugitive dust control required on the paved surfaces within the boundries and jurisdiction of the party of the second part.

3. It is agreed tha the party of the second part will within two months of the date of this agreement adot a resolution stating that it is the policy of the party of the second part to modify street cleaning practices to meet air quality objectives; within six months of the ate of this agreement specify and submit to the party of the first part a detailed proram for implementing said policy, which program shall include such elements as both paries agree to be necessary; and at the time of the next following budget approval submit to the party of the first part an operating budget and capital expenditures budgt which provides the fundings necessary to implement the programs so developed.

4. It is agreed tha the party of the first part and the party of the second part will equally share the expense of determining the degree and extent of dust control required, and that the paty of the first part will assist the party of the second part in finding supplementary surces of funding to implement the programs developed as a part of this agreement.

IN TESTIMONY WHEREOF the parties hereto have caused this agreement to be executed, in duplicate, by their duly authorized agents and/or officials, as of the day and year first above written.

ATTEST: STATE OF ____________________

______________________________ By____________________________
Secretary Executive Director,
Department of Environmental
Protection

ATTEST: CITY OF ____________________

______________________________ By____________________________
Clerk Mayor

Figure 8.1. Example administrative agreement.

There has been no indication whether such a nonregulatory approach would be approvable by EPA if submitted as part of an SIP revision. The Federal regulations (40 CFR 51.11f) do allow the state to delegate authority to carry out part of the plan:

> "The State may authorize a local agency to carry out a plan, or portion thereof, within such local agency's jurisdiction: Provided, that such plan demonstrates, to the Administrator's satisfaction, that such local agency has the legal authority necessary to implement such plan, or portion thereof, and further: Provided, that such authorization shall not relieve the State of responsibility under the Act for carrying out such plan, or portion thereof."

The municipalities certainly have legal authority to clean their streets. The uncertainty arises in whether every measure identified in the control strategy must be backed by a regulation. Also, the agency has no basis for seeking injunctive relief for nonperformance by the municipality and has no legal authority for cleaning the streets if the municipality fails to do so.

No precedents for comparable situations to this could be found in other EPA regulatory areas. The agreement shows recognition of the state agency's objectives and an intent to comply with program requirements that are not as yet defined because they must be designed specifically for each municipality.

IMPLEMENTATION OF AN ADMINISTRATIVE AGREEMENT

There are five basic elements to the process of developing the type of administrative agreement discussed herein:

- decision by the air pollution control agency that improved street cleaning is necessary in order to attain and maintain air quality standards;
- establishment of a joint institutional mechanism with the public works department to define the nature of such improvements;
- provision of active technical assistance on the part of the air pollution control agency;
- adoption of altered street cleaning practices as a matter of local governmental policy;
- development of program elements designed to implement and assess those desired improvements.

The first of these is amply discussed in other portions of this report and need not be discussed further here.

Institutional Mechanisms

Modifications to the street cleaning program determined independently by the air pollution control agency have no better chance of being implemented than equivalent regulations adopted by the agency. Rather, what is required is an institutional process for agreeing upon changes that can be fitted into the existing street cleaning operations with the optimum mix of minimized change and maximized air pollution control effectiveness.

It is suggested that a committee comprised of representatives of both organizations be appointed to determine the technical means of achieving the desired degree of improvement in air quality. This committee process might be rather difficult to implement in practice due to differing organizational imperatives.

Technical Assistance

A public works department cannot be expected to know what must be done to reduce the air quality impact of reentrained dust from paved streets. Nor can an air pollution control agency be expected to know what must be done to clean streets efficiently and effectively. Each group must work with the other, as is implied by the administrative agreement concept, to determine what must be done to produce mutally desirable results.

To this end, the air pollution control agency must provide three services: guidelines as to what equipment and procedures are most beneficial in terms of air quality; directions as to what parts of the municipality are most in need of improved air quality, and air quality sampling data which can be used to monitor and assess the effect of modifications in the existing street cleaning system.

Municipal Policy Development

In making policy decisions that add, delete, or modify community objectives, municipal administrations are usually responding to public pressure, special interest groups, perceived need by the administration itself, or consideration of requirements or desires of other governmental entities. The municipal administration must determine the likely costs and benefits of the improvements in air quality that can be expected from altered street cleaning practices and where and how the necessary modifications in activities and expenditures are to be made. Once these questions have been satisfactorily answered the municipal administration can then draft a resolution stating the policy to be followed and submit it to the city council for a vote under its prescribed rules of ratification. Wording of the resolution in each municipality will vary, but may approximate the model shown in Figure D-2. Following favorable adoption of such a resolution, administrative and other legislative actions will be required to implement the policy. The first administrative step involves program planning and development.

BY THE COUNCIL:

WHEREAS, this Council has, through the State Department of Environmental Protection, become aware of overall air quality plan objectives for the State and this municipality; and

WHEREAS, this Council recognizes that national air quality objectives are embodied in the State objectives; and

WHEREAS, this Council also recognizes the need to modify street cleaning practices in order to meet air quality objectives and protect the health and welfare of the citizens of this municipality; and

WHEREAS, this Council has been advised that by reordering public works expenditures and procedures and modifying existing powers and programs that this municipality can achieve a significant measure of air quality improvement through control of reentrained dust;

NOW THEREFORE, BE IT RESOLVED by the Village/City Council of this municipality, that program plans and implementation be directed toward a systematic modification of street cleaning practices;

BE IT FURTHER RESOLVED that the Department of Public Works is directed to cooperate with the State Department of Environmental Protection to define jointly the nature, degree, and extent of those modifications which are necessary to implement this policy; and

BE IT FURTHER RESOLVED that the Clerk of this Council is hereby directed to certify copies of this resolution to Village/City Directors of Public Works, Office of Budget, and Community Planning for program planning and execution.

ADOPTED at a regular meeting of the Village/City Council of Any County, Every State this ____________ day of ___________, 19__.

Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY

CERTIFICATE OF CLERK

IT IS HEREBY CERTIFIED that the foregoing is a true and correct transcript of a resolution adopted by this Council in session the _________ day of ________, 19__.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the Village/City Council of Any County, Every State this _________ day of _________.

____
Clerk
Village/City Council

Figure B.2. Example city council resolution.

Program Planning and Development

Programs are action-oriented media for carrying out policies. The increasing complexity, number, and technical character of municipal problems makes it necessary that program planning be accomplished in a systematic manner. Moreover, the multiplicity of municipal needs that compete for funds makes it imperative that any new program or major program modification be well-conceived and well-presented.

Programming provides the framework for rational decisions. This framework may be categorized into assessing existing programs, determining where these programs can be most effectively applied, identifying new areas of concern, designing new programs, and scheduling new programs.

Programming options for controlling dust from municipally-owned paved surfaces are largely limited to public works or street cleaning functions and activities. To achieve improved reentrainment dust control may require improved maintenance of existing street cleaning equipment, purchase of new or different equipment, improvement of employee training programs, more frequent street sweeping, and/or modifying the specific sequence of activities in a given area. It may be desirable to program joint agreements with neighboring jurisdictions. In addition, programs related to Areawide Waste Treatment Management Planning (Section 208, P.L. 92-500) requirements may need to be integrated with those related to air quality.

According to the International City Manager's Association (ICMA),[2] there are four basic ingredients to the actual process of developing street cleaning programs:

- adequate planning maps,
- definition of desirable frequency and time of cleaning for individual streets,

- development of routes, and
- scheduling control.

The air pollution control agency should obtain enough of this type of information from the public works department so that the agency can interactively determine with the department what modifications need to be made as a part of the effort to reduce reentrained dust from paved surfaces.

Budgeting Mechanisms

Implementing the changes agreed upon during the process of program development will require modifications in the budget that would otherwise be prepared. Such modifications may include the same budgeting mechanisms as used for other municipal functions: the annual operating budget and the capital improvements budget.

A reordering of existing budget priorities may be necessary. For example, if more frequent cleaning is required in a specific part of the municipality, then either services will be cut back in other parts of town, productivity will increase, funds will be shifted to the public works department from other departments, or an increase in overall financial resources will be obtained. These alternatives clearly imply that a thorough analysis of how the requisite changes can be implemented most efficiently is required. Likewise, additional street cleaning equipment may have to be purchased. The air pollution control agency must make every effort to provide the public works department with the best possible information concerning the air pollution control effectiveness of different types of street cleaning equipment.

Any effort to improve street cleaning practices will have to be conceived with recognition that funding sources for local governments are limited and that the fundable improvements must first be incorporated in the next year's approved budget, which would prevent very rapid implementation.

REFERENCES

1. Control of Reentrained Material from Paved Streets. Prepared by PEDCo Environmental, Inc. for U.S. Environmental Protection Agency, Region VII, March 1976 (Draft).

2. Korbitz, W.E. (Ed.) Urban Public Works Administration. Washington D.C., International City Management Association, 1976.

TASK D/E REPORT
EMISSION MODELING AND CONTROL STRATEGY DEVELOPMENT
(RENO)

1. INTRODUCTION

At the present time the National Ambient Air Quality Standard (NAAQS) for Total Suspended Particulate (TSP) is being exceeded in the Northwest Nevada Intrastate (Reno) Air Quality Control Region (AQCR). Since relatively few uncontrolled point sources and conventional area sources of TSP have been identified in this region, the probability exists that the impact on TSP air quality from fugitive dust sources is causing non-attainment. Therefore, as part of a multiphase effort to resolve this problem, PEDCo Environmental has assembled and analyzed all available air quality and meteorological data for the base year 1975 in the study areas to better identify the nature of the particulate problem. "Microinventories" of the areas surrounding each sampling location were also conducted to determine specific sources and source categories influencing the measurements at the sites. Additionally, pertinent factors which influence the generation of fugitive TSP in this geographical area were evaluated and defined. Using these factors, an emission inventory of the study area was produced for both the base year (1975) and the projected years of 1980 and 1985. These data have been tabulated in Section 2.0 of this report in a format prescribed for modeling. The model chosen for evaluation of TSP control strategies, the "Hanna-Gifford" relationship, is described in Section 3.0.

Once the data base was assembled, and the model validated for use in this region, meetings were held with local and state agency personnel in order to review potential control measures for the significant TSP source categories. The options chosen for evaluation relative to control of fugitive emissions are defined in Section 5.0.

In order to obtain the most realistic projections of TSP control options on air quality, it was decided to use a "weighing factor" developed during the special project effort devoted to characterization of the airborne particulate in this specific area. Simply stated, this factor was developed in order to account for the disparity observed between the percent mineral composition of hi-volume samples and the percent of mineral emissions detected in the inventory. The development of this factor is discussed in detail in Section 6.0.

Section 7.0 of this report summarizes the results of the control strategy modeling effort. Section 8.0 presents a discussion of both existing and proposed regulatory considerations which directly relate to possible implementation of the control options evaluated.

2. EMISSION INVENTORIES

When evaluating a total suspended particulate (TSP) problem, it is necessary to develop an emission inventory. The emission inventory data presented in this section are the summary tables of the Task C Report.[1] Detailed explanation of the development of the base year and projected emissions inventories is contained in that report. The emission categories, conventional except for several fugitive dust categories which have been included, are as follows:

- Stationary
    - Residential/commercial/industrial fuel combustion
    - Industrial processes
    - Burning
- Mobile
    - Aircraft/railroad
    - Highway vehicles
    - Off-highway vehicles
- Fugitive dust
    - Construction
    - Dust entrainment from paved roads (normal and dirty)
    - Unpaved roads
    - Sand and gravel pits
    - Agriculture
    - Street sanding
    - Various fugitive dust sources (including - cleared areas, playgrounds, unpaved parking lots, railroad right-of-ways and yards, heavy equipment storage, road shoulders, and horse corrals).

To identify areas of high emission concentrations and apply diffusion modeling techniques, it was necessary to establish a grid network covering the study area and allocate the emission totals throughout the grid system. The grid overlay is shown in Figure 2.1 and the allocation

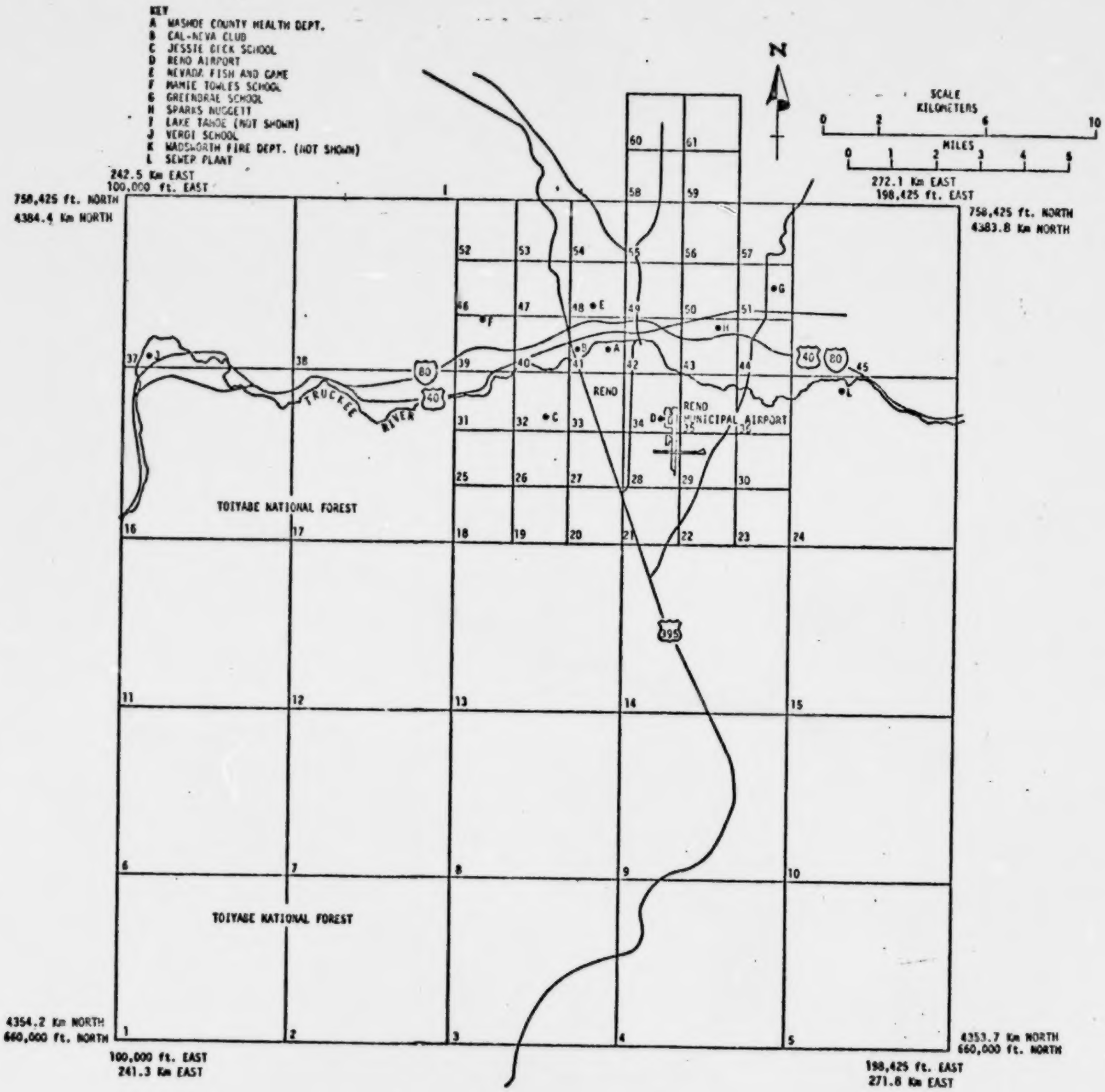
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
N
SCALE
KILOMETERS
0
2
6
10
MILES
0
1
2
3
4
5
242.5 Km EAST
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
272.1 Km EAST
198,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
TRUCKEE RIVER
80
40
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
395
TOIYABE NATIONAL FOREST
4354.2 Km NORTH
660,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
198,425 ft. EAST
271.8 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH

Figure 2.1 Reno study area with grid overlay.

procedures explained in the Task C Report.[1] Tables 2.1, 2.2 and 2.3 show emission inventories by source category and by grid for 1975, 1980 and 1985, respectively. Table 2.4 shows the category breakdown of the various fugitive emissions, which are estimated to remain relatively constant for each of the study years. Table 2.5 shows the annual percentage increase in emissions from each source category. These growth factors were used to project 1975 emissions to 1980 and 1985.

A category not included in the emission inventory is dust from natural surfaces. However, emissions from this category were developed and included in the model because of their localized influence. Natural surface emissions were determined to be a variable source whose emission strength is a function of soil type and the amount of natural surface area in each grid. Development of emissions from this source category are explained in the following section.

NATURAL SURFACE EMISSIONS

In an attempt to account for emissions from sources which were not covered in the emission inventory, the source category of natural surfaces was developed.

Emission Factors

As a first approximation, based on the emission factor for cleared areas (Task B Report,[2] page 2-4), the emission factor for undisturbed surfaces must be equal to or less than 0.02 ton/acre/yr, or 12.8 ton/mi^2/yr. In order to obtain a better estimate of what this value might be, several methods were used.

The average background in the Reno Study area is 20 $\mu g/m^3$, based on the intercept of emission density vs. air

Table 2.1. EMISSIONS SUMMARY BY GRID, RENO, 1975[a]

(ton/yr)

Grid	Stationary: Fuel comb.	Stationary: Ind. proc.	Stationary: Burning	Mobile: Rail /air	Mobile: Auto exh.	Mobile: Off hwy. exh.	Fugitive dust: Constr.	Fugitive dust: Norm. str.	Fugitive dust: Dirty str.	Fugitive dust: Unpav. roads	Fugitive dust: Sand/ grav.	Fugitive dust: Agric.	Fugitive dust: Str. sand	Fugitive dust: Var. fugit. sourc.	Total ton/yr	Emiss. dens., ton/ mi²/yr
1																-
2																
3	0.6		124.8		10.7		0.7	25.4		162					374.2	23.3
4	0.6		124.8				0.7	0.1		205					331.2	23.8
5			62.4							65					127.4	9.2
6																
7					-					11					11.0	6.8
8	0.9		124.9		2.4		5.3	5.8		258					397.3	28.6
9	5.5		125.1		23.0	0.7	12.6	54.5		205					426.4	30.7
10	0.3		62.4		1.5			3.7		226	66				359.9	25.9
11																
12			2.0							108					110.0	7.9
13	4.3		125.3		0.2	1.0	10.1	0.5		129					270.4	19.5
14	9.8		125.9		25.0	1.9	81.7	59.1		86					389.4	28.0
15			62.4							162					224.4	16.1
16	1.6		2.2	5.9	13.7		5.8	32.3		86				3.4	150.9	10.9
17	6.8		2.4	4.9	12.8	0.6	10.4	30.3		258				2.6	328.8	23.7
18	1.3									43					44.3	28.7
19	0.9						5.8	0.8							7.5	4.9
20	3.4				0.9			2.2							6.5	4.2
21	5.6		1.1		9.7	1.7	48.6	23.0							89.7	58.1
22	1.2		6.9		1.7		11.6	4.1							25.5	16.5
23			7.0				22.0			22					51.0	33.0
24	4.2		62.6	1.3	0.2		3.6	0.4		194		26		0.6	292.9	21.1
25	3.4						5.8								9.2	6.0
26	6.1		1.3		1.9	2.1	22.8	4.4					1.0		39.6	25.6
27	11.4		1.9		16.3	2.9	16.3	38.6					8.5		95.9	62.1
28	16.1		1.1	4.7	7.6	1.8	21.1	18.0					4.0		74.4	48.2
29	2.3		7.0	2.4	2.5		22.0	5.6				53			95.0	61.5
30	0.2		7.0		0.7		22.0	1.6							31.5	20.4
31	12.7		2.0	1.0	2.6	3.2	9.4	6.2					1.4	0.6	39.1	25.3
32	18.4		3.4		13.8	5.3	16.2	32.6					7.2	16.2	113.1	73.3
33	40.5		5.6		36.3	8.8	24.3	85.9					18.8	2.6	222.8	144.3
34	13.0		1.2	2.4	12.1	1.9	11.2	28.6		9	13		6.3	13.7	112.4	72.8
35	0.6		0.1		2.3		16.2	5.5							24.7	16.0
36	0.7		7.0		1.6		16.2	3.7				39			68.2	44.2
37	0.4		2.1	1.7	0.9		9.4	2.1		179				5.1	200.7	14.4
38	0.1		2.0				5.8			323					330.9	23.8
39	25.9		3.9	0.4	9.5	6.1	16.4	22.5		9			4.9	12.5	111.1	72.0
40	23.1		3.7	1.4	34.2	5.8	12.0	81.0					17.8	1.4	180.4	116.8
41	17.5		4.0	1.5	67.9	6.3	10.2	160.6		6		1	35.2	3.1	313.3	202.9
42	4.3	19.0	1.1	1.4	34.3	1.8	10.5	81.3		163	131		17.9	5.5	471.1	305.1
43	6.5		0.8	2.7	16.3	1.2	16.0	37.3	20.6					22.2	123.6	80.1
44	2.1		0.1	1.2	6.0		27.1	14.2		170				5.3	226.0	146.4
45	6.7	4.0	2.0	1.3	6.4		5.8	15.3		75	250			2.1	368.6	26.5
46	15.9		0.5		0.8	0.6	9.1	1.8		108			0.4	3.2	140.3	90.9
47	18.6		2.4		9.3	3.7	16.7	22.1		2			4.9	0.1	79.8	51.7
48	8.1		2.5		9.7	4.0	14.4	22.9		60		2	5.0	49.1	177.7	115.1
49	9.8		2.5		12.9	4.0	12.2	30.5					6.7		78.6	50.9
50	27.1		4.8		13.0	7.5	31.0	30.8						1.4	115.6	74.9
51	23.3		1.2		3.3	1.8	40.5	7.7		28				10.5	116.3	75.3
52	0.2		0.1							22					22.3	14.4
53	1.1		1.5		3.0	2.3	2.1	7.1		22				0.3	39.4	25.5
54	1.1		0.3		0.8	0.5	4.0	1.8		22				0.1	30.6	19.8
55	1.6		0.2		4.2		2.8	9.9						12	30.7	19.9
56	4.8		0.9		2.8	1.4	59.4	6.7							76.0	49.2
57	11.8		1.2		1.5	1.6	28.9	3.6		22					70.8	45.9
58	1.2		0.5		0.2	0.8	17.1	0.4		86					106.2	68.8
59	0.5				0.2		5.8	0.4		57					63.9	41.4
60	2.7		0.5		0.4	0.8	17.0	0.7		229				7	258.1	167.2
61	1.4		0.5		0.2	0.8	17.0	0.3		157					177.2	114.8
Tot.	388.2	23.0	1099.5	35.4	437.3	85.5	814.0	1034.1	20.6	3969.0	460.0	121.0	140.0	180.6	8808.2	

[a] Natural surface emissions, while part of the inventory, are not included. See Table 2.6.

Table 2.2. EMISSIONS SUMMARY BY GRID, RENO, 1980[a,b]
(ton/yr)

Grid	Stationary			Mobile			Fugitive dust								Total ton/yr	Emiss. dens., ton/mi²/yr
	Fuel comb.	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy. exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Str. sand	Var. fugit. sourc.		
1																
2																
3	0.6		132.8		8.8		0.8	29.2		162					334.2	24.0
4	0.6		132.8		0.3		0.8	1.0		205					340.5	24.5
5			66.4							65					131.4	9.5
6																
7										11					11.0	0.8
8	1.1		132.9		5.4		5.9	17.7		258					421.0	30.3
9	6.6		133.1		15.0	0.8	13.8	49.7		205					424.0	30.5
10	0.3		66.4		1.1			3.6		225	66				362.2	26.1
11																
12			2.0							108					110.0	7.9
13	4.8		133.4		4.0	1.1	11.2	13.3		129					296.8	21.4
14	14.0		89.8		17.8	2.8	90.2	58.9		86					359.5	25.9
15			66.4		0.3			1.0		162					229.7	16.5
16	1.9		2.2	6.8	12.7		6.5	42.1		86				3.4	161.6	11.6
17	7.6		2.4	5.7	12.3	0.7	11.5	40.7		258				2.6	341.5	24.6
18	1.3				0.3			0.9		43					45.5	29.5
19	0.9				0.7		6.4	2.4							10.4	6.7
20	3.4				2.9			9.8							16.1	10.4
21	6.9		1.2		9.4	2.2	53.8	31.0							104.5	67.7
22	1.2		7.4		1.8		12.7	5.9							29.0	18.8
23			7.5				24.3	0.1		22					53.9	34.9
24	4.8		66.6	1.6	0.6		4.0	2.1		194		26		0.6	300.3	21.6
25	3.4				0.7		6.4	2.2							12.7	8.2
26	6.8		1.4		1.5	2.3	25.2	5.0					1.0		43.2	28.0
27	12.1		2.1		14.0	3.1	18.1	46.4					8.5		91.7	59.4
28	17.7		1.2	6.7	8.8	2.0	23.5	29.3					4.0		93.2	60.4
29	5.7		0.1	3.3	2.2		24.3	7.1				53			95.7	62.0
30	0.6		0.1		1.1		24.3	3.5							29.6	19.2
31	13.1		2.2	1.1	2.8	3.3	10.4	9.4					1.4	0.6	44.3	28.7
32	19.1		3.8		10.3	5.5	17.8	34.0					7.2	16.2	113.9	73.8
33	41.7		6.2		29.0	9.1	26.9	95.8					18.8	3.6	230.1	149.0
34	13.8		1.3	3.3	12.4	2.0	12.4	41.2		9	13		6.3	13.7	128.4	83.2
35	1.4		0.1		2.1		17.8	6.9							28.3	18.3
36	1.7		0.1		1.5		17.8	5.1				39			65.2	42.2
37	1.0		2.1	2.0	0.9		10.4	2.9		179				5.1	203.4	14.6
38	0.1		2.0		0.6		6.4	2.1		323					334.2	24.0
39	26.6		4.3	0.5	8.4	6.3	18.2	27.8		9			4.9	12.5	118.5	76.7
40	23.6		4.1	1.7	25.8	5.9	13.4	85.2					17.8	1.4	178.9	115.9
41	17.8		4.4	1.7	53.6	6.4	11.3	177.3		6		1	35.2	3.1	317.8	205.8
42	4.6	21.9	1.2	1.7	30.1	1.9	11.6	99.8		163	131		17.9	5.5	490.2	317.5
43	7.4		0.9	3.1	14.7	1.4	17.7	47.3	20.6					22.2	135.3	87.6
44	4.5		0.1	1.3	5.3	0.1	29.9	17.5		170				5.3	234.0	151.6
45	6.7	4.6	2.0	1.5	6.7		6.4	22.1		75	250			2.1	377.1	27.1
46	18.0		0.5		1.9	0.7	10.1	6.2		108			0.4	3.2	149.0	96.5
47	19.6		2.6		8.8	3.9	18.5	29.1		2			4.9	0.1	89.5	58.0
48	8.4		2.8		8.6	4.1	15.9	28.5		60		2	5.0	49.1	184.4	119.4
49	10.1		2.8		13.0	4.1	13.4	43.1					6.7		93.2	60.4
50	27.8		5.3		9.0	7.8	34.1	29.9						1.4	115.3	74.7
51	28.4		1.3		2.4	2.3	44.7	7.8		28				10.5	125.4	81.2
52	0.2		0.1							22					22.3	14.4
53	1.1		1.7		3.4	2.3	2.4	11.4		22				0.3	44.6	28.9

Table 2.2 (continued). EMISSIONS SUMMARY BY GRID, RENO, 1980[a,b]
(ton/yr)

Grid	Stationary			Mobile			Fugitive dust								Total ton/yr	Emiss. dens., ton/mi²/yr
	Fuel comb.	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy. exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Str. sand	Var. fugit. sourc.		
54	1.2		0.3		2.0	0.6	4.4	6.6		22				0.1	37.2	24.1
55	1.8		0.2		5.1		3.2	16.9						12	39.2	25.4
56	6.5		1.0		3.6	2.0	65.7	12.0							90.8	58.8
57	13.3		1.3		1.7	2.2	31.9	5.6		22					78.0	50.5
58	1.5		0.6		0.3	1.0	18.8	0.8		86					109.0	70.6
59	0.5				0.2		6.4	0.7		57					64.8	42.0
60	3.4		0.6		0.5	1.0	18.8	1.4		229				7	261.7	169.5
61	1.8		0.6		0.2	1.0	18.8	0.6		157					180.0	116.6
Tot.	428.3	26.6	1105.2	42.0	386.6	94.3	899.2	1277.9	20.6	3969.0	460.0	121.0	140.0	180.6	9151.3	

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[a] Natural surface emissions, while part of the inventory, are not included. See Table 2.6.

[b] Present emissions are based on existing programs. They do not include reductions attributable to control strategies described in Section 7.0.

Table 2.3. EMISSION SUMMARY BY GRID, RENO, 1985[a,b]

(ton/yr)

	Stationary			Mobile			Fugitive dust									
Grid	Fuel comb.	Ind. proc.	Burning	Rail /air	Auto exh.	Off hwy. exh.	Constr.	Norm. str.	Dirty str.	Unpav. roads	Sand/ grav.	Agric.	Str. sand	Var. fugit. sourc.	Total ton/yr	Emiss. dens., ton/ mi²/yr
1																
2																
3	0.7		148.8		8.0		0.8	33.0		162					353.3	25.4
4	0.7		148.8		0.5		0.8	2.0		205					357.8	25.7
5			74.3							65					139.3	10.0
6																
7										11					11.0	0.8
8	1.3		148.9		7.2		6.6	29.7		258					451.7	32.5
9	8.1		149.2		10.9	1.0	15.5	44.9		205					434.6	31.3
10	0.3		74.3		0.9			3.6		226	66				371.1	26.7
11																
12			2.0							108					110.0	7.9
13	5.4		124.6		6.3	1.2	12.6	26.1		129					305.2	22.0
14	19.5		51.1		14.2	3.9	101.3	58.6		86					334.5	24.1
15			74.3		0.5			1.9		162					238.7	17.2
16	2.4		2.2	7.9	12.6	0.1	7.2	51.9		86				3.4	173.7	12.5
17	8.9		2.5	6.6	12.4	0.9	12.9	51.1		258				2.6	355.9	25.6
18	1.3				0.4			1.7		43					46.4	30.1
19	0.9				1.0		7.2	4.0							13.1	8.5
20	3.4				4.2			17.3							24.9	16.1
21	8.7		1.4		9.4	2.9	60.3	39.0							121.7	78.8
22	1.2				1.9		14.4	7.7							25.2	16.3
23			0.1		0.4	0.7	27.2	1.7		22					52.1	33.7
24	5.8		41.5	1.0	0.8		4.4	3.8		194		26		0.6	278.8	20.1
25	3.4				1.1		7.2	4.4							16.1	10.4
26	2.0		1.6		1.4	2.7	28.2	5.6					1.0		42.3	21.3
27	13.1		3.4		13.1	3.3	20.3	54.2					0.5		114.9	74.4
28	20.1		1.4	8.3	9.8	3.3	26.3	40.5					4.0		112.7	73.0
29	10.4		0.1	4.2	2.0	0.7	27.2	8.5				53			106.1	68.7
30	1.1		0.1		1.3	0.7	27.2	5.3							35.7	23.1
31	13.6		2.5	1.3	3.0	3.4	11.6	12.5					1.4	0.6	49.9	32.3
32	19.9		4.2		8.5	5.7	20.0	35.3					7.2	16.2	117.0	75.8
33	63.3		4.9		25.6	9.4	30.3	105.7					0.8	2.6	242.6	157.1
34	15.0		1.5	4.2	13.0	2.2	13.8	53.8		9			6.3	13.7	132.5	85.8
35	3.4		0.1		2.0	0.6	20.0	7.3							33.4	21.6
36	2.9		0.1		1.5	0.6	20.0	6.4				39			70.5	45.7
37	1.7		2.1	3.3	0.9		11.6	3.7		179				3.1	206.4	14.8
38	0.1		2.0		1.0		7.2	4.2		323					337.5	24.3
39	27.7		4.8	0.6	8.0	6.6	20.5	33.1		9			4.9	12.5	127.7	82.7
40	24.4		4.6	1.9	21.6	6.1	14.9	89.5					17.8	1.4	182.2	118.0
41	18.2		5.0	2.0	46.9	6.6	12.7	193.9		6		1	35.2	3.1	330.6	214.1
42	4.9		3.4	1.0	20.6	2.0	13.0	118.3		27			17.9	5.5	220.5	142.8
43	8.7		1.0	3.6	14.2	1.6	19.9	57.3	20.6					22.2	149.1	96.6
44	7.9		0.1	1.6	5.0	0.9	33.4	20.8		170				5.3	245.0	158.7
45	6.7	5.2	2.0	1.7	7.0		7.2	29.0		75	250			2.1	385.9	27.8
46	21.3		0.6		3.4	0.8	11.3	10.6		108			0.4	3.2	158.6	102.7
47	20.8		3.0		8.7	4.2	20.7	36.1		2			4.9	0.1	100.5	65.1
48	8.8		3.1		8.2	4.3	17.7	34.0		60		2	5.0	49.1	192.2	124.5
49	10.6		3.1		13.5	4.3	15.1	55.8					6.7		109.1	70.7
50	38.9		5.9		7.0	8.3	38.3	20.9						1.4	110.7	76.9
51	35.3		1.5		1.9	3.9	30.2	7.9		38				20.5	138.1	89.4
52	0.2		0.1							22					22.3	14.4
53	1.1		1.9		3.8	2.4	3.6	15.7		22				0.3	49.8	32.3
54	1.3		0.4		2.8	0.6	5.0	11.4		22				0.1	43.6	28.3
55	3.0		0.2		5.8		3.5	23.0						12	47.3	30.6
56	5.9		1.1		6.2	3.9	73.7	17.3							108.1	70.0
57	19.5		1.5		1.0	2.6	35.8	7.5		22					86.7	56.2
58	1.9		0.6		0.3	1.2	21.1	1.2		86					112.3	72.7
59	0.5				0.3		7.2	1.1		57					66.1	42.8
60	4.3		0.6		0.6	1.3	21.1	2.1		229				7	265.9	172.2
61	2.1		0.6		0.3	1.3	21.1	1.0		157					183.5	118.8
Tot.	482.4	5.2	2112.3	49.9	369.6	105.3	1002.0	1522.7	20.6	3833.0	316.0	121.0	180.6	180.6	9266.2	

[a] Natural surface emissions, while part of the inventory, are not included. See Table 2.6.

[b] Present emissions are based on existing programs. They do not include reductions attributable to control strategies described in Section 7.0.

Table 2.4. VARIOUS FUGITIVE DUST SOURCES FOR RENO - CONSTANT FOR THE PERIOD 1975-85 (tons/year)

Grid	Cleared areas	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16				3.4				3.4
17				2.6				2.6
18								
19								
20								
21								
22								
23								
24				0.6				0.6
25								
26								
27								
28								
29								
30								
31				0.6				0.6
32		12.8	3.1			0.3		16.2
33		2.6						2.6
34	8.1	3.9	1.2		0.5			13.7
35								
36								
37		3.8	0.1	1.0		0.2		5.1
38								
39	1.5	10.8		0.2				12.5
40	0.5			0.9				1.4
41	0.9		0.2	2.0				3.1
42		2.1	0.4	0.8	2.2			5.5
43	0.3	2.1	3.0	16.1	0.7			22.2
44				5.3				5.3

Table 2.4 (continued). VARIOUS FUGITIVE DUST SOURCES FOR RENO - CONSTANT FOR THE PERIOD 1975-85 (tons/year)

Grid	Cleared areas	Play-grounds	Unpaved parking lots	Railroad right-of-way	Heavy equipment storage	Road shoulders	Horse corral	Total
45			0.9	1.2				2.1
46	3.2							3.2
47				0.1				0.1
48	3.6	3.9	29.9	0.4		2.3	9.0	49.1
49								
50	1.4							1.4
51	1.6	8.9						10.5
52								
53				0.3				0.3
54				0.1				0.1
55	12.0							12.0
56								
57								
58								
59								
60	7.0							7.0
61								
Total	40.1	50.9	38.8	35.6	3.4	2.8	9.0	180.6

Table 2.5. SOURCE CATEGORY GROWTH FACTORS FOR RENO

Category	Annual growth factor, % 1975-1980	Annual growth factor, % 1975-1985	Type of growth	Basis for factor
Stationary sources				
Fuel combustion	2.0	2.2	compound	population increase
Industrial processes	3.1	2.9	simple	manufacturing dollars
Burning				
Controlled/uncontrolled	0	0	no change	
Structural/incineration	2.0	2.2	compound	population increase
Mobile sources				
Aircraft	4.8	4.8	compound	LTO increase
Railroad	3.0	3.0	compound	rail activity
Highway				
Heavy-duty gas/diesel	0	0	no change	
Light-duty gas	4.7[a]	4.7[a]	simple	VMT increase
Off-highway	2.0	2.2	compound	population increase
Fugitive dust sources				
Construction	2.0	2.2	compound	population increase
Normal paved streets	4.7	4.7	simple	VMT increase
Dirty paved streets	0	0	no change	
Unpaved roads	0	0	no change	
Sand and gravel pits	0	0	no change	
Agriculture	0	0	no change	
Street sanding	0	0	no change	
Various fugitive sources	0	0	no change	

[a] Although VMT increased at this rate, the emission factors for light-duty vehicles are expected to decrease due to the continued use of unleaded fuel.

quality curve from the Task A Report.[3] No sulfate or benzene soluble data are available in Reno. However, it was assumed that concentrations are similar to those in Las Vegas (reported by the Clark County District Health Department, Air Pollution Control Division). Some of the sulfates could be mineral in origin rather than from the atmospheric conversion of SO_2. Assuming that the aerosol portion of airborne sulfates is uniform throughout the study area, the lowest sulfate concentration measured in the network should provide a reasonable estimate of this aerosol portion. This value was reported to be 2.5 $\mu g/m^3$ in Las Vegas.

Some organic material in the fugitive dust could also be measured in the benzene soluble fraction, as opposed to the condensed organics in the atmosphere. Therefore, the lowest concentration is again used as a rationale for selecting the aerosol portion of the organics. A concentration of 2.5 $\mu g/m^3$ from the Las Vegas "background" site was used. Therefore, of the 20 $\mu g/m^3$ background concentration in Reno, 5 $\mu g/m^3$ are estimated to be attributable to sulfates and benzene solubles.

Another 2 $\mu g/m^3$ can be assumed to be from long range transport, and 1 $\mu g/m^3$ due to biological "debris" (pollen, spores, fibers, leaf parts, seeds). Thus, the local influence is approximately 12 $\mu g/m^3$. From a curve of emission density vs. air quality, shown in the Task A Report,[3] a 12 $\mu g/m^3$ increment of particulate concentration corresponds to an emission density of approximately 27 ton/mi^2/year. This value is above the maximum emission factor of 12.8 ton/mi^2/year, and therefore is assumed not valid for this study.

Another method used to determine emission density is dispersion modeling. The basic equation for ground level emissions is

$$\chi = Q/\pi \sigma_y \sigma_z u$$

where

χ = concentration due to local influence, 12 $\mu g/m^3$
Q = source strength, g/sec
u = wind speed, m/sec
σ_y = standard deviation of dispersion in y direction, m
σ_z = standard deviation of dispersion in z direction, m

The values of σ_y and σ_z are dependent on atmospheric stability class and a length factor, d, where

$d = \sigma_{yo} + S/2$, $\sigma_{yo} = S/4.3$, and S is the length of the side of a square grid. For a 1 mi^2 area, S = 1 mile = 1.61 km, and so d ≈ 1.2 km. Using the most common stability class, D, σ_y and σ_z at 1.2 km are 80 m and 36 m, respectively. Assuming a wind speed of 6.3 mph (2.82 m/sec), the emission strength, Q is calculated to be

$Q = (12\ \mu g/m^3)(\pi)(80m)(36\ m)(2.82\ m/sec)(1\ gram/10^6\ \mu g)$
$Q = 0.31$ g/sec from the 1 mi^2 area, or 0.31 $g/mi^2/sec$
$Q = (0.31\ g/mi^2/sec)(1\ ton/9.07 \times 10^5\ g)(3.1536 \times 10^7\ sec/yr)$
$Q = 10.6\ ton/mi^2/yr$

Since this is only an approximation, this value was averaged with the maximum emission factor to obtain an emission density for undisturbed surfaces having an average soil type. This average is (12.8 + 10.6)/2 ≈ 12 $ton/mi^2/year$.

Based on ratios of soil type correction factors found on page 4-5 of the Task B Report,[2] the emission density from gravelly soil is reduced to 6 $ton/mi^2/year$. For rocky soil and urban areas (grass, asphalt and concrete) the emissions from natural surfaces are negligible.

Emission Calculations

These factors were applied in the following manner. Soil type maps[4] were used to determine the percent of each soil type (loamy and gravelly) in each grid, as indicated in the first two columns of Table 2.6. From land use maps,[5] the percentage of natural surfaces in each grid was estimated and entered in column four. It was assumed that the soil types were evenly distributed over each grid, rather

Table 2.6 EMISSION FROM NATURAL SURFACES IN RENO - 1975-80-85 (tons/year)

Grid	Percent soil type of entire grid[b]		Percent natural surface of grid[c]	Total natural surface emission, ton/year		
	loamy[a]	gravelly		1975	1980	1985
1		100	100	83.4	83.4	83.4
2		100	100	83.4	83.4	83.4
3	60	40	90	119.5	119.5	119.5
4	100		90	150.1	150.1	150.1
5		100	100	83.4	83.4	83.4
6		100	100	83.4	83.4	83.4
7		100	100	83.4	83.4	83.4
8	35	65	90	101.5	101.5	101.5
9	100		80	133.4	133.4	133.4
10	35	65	90	101.5	101.5	101.5
11		100	100	83.4	83.4	83.4
12		100	100	83.4	83.4	83.4
13	50	50	100	125.1	125.1	125.1
14	100		60	100.1	100.1	100.1
15	35	65	100	112.6	112.6	112.6
16	35	65	60	68.1	68.1	68.1
17	25	75	75	77.8	77.8	77.8
18		100	85	13.3	13.3	13.3
19		100	65	10.2	10.2	10.2
20	30	70	45	9.1	9.1	9.1
21	100		35	10.9	8.8	6.8
22	100		50	15.6	15.2	14.7
23	100		80	25.0	24.0	23.0
24	25	75	80	83.4	83.4	83.4
25		100	40	6.3	6.3	6.3
26		100	30	4.7	4.2	3.7
27	40	60	0	0.0	0.0	0.0
28	100		0	0.0	0.0	0.0
29	100		0	0.0	0.0	0.0
30	100		20	6.3	5.3	4.3
31	50	50	0	0.0	0.0	0.0
32	25	75	0	0.0	0.0	0.0
33	75	25	0	0.0	0.0	0.0
34	100		20	6.3	5.9	5.4
35	100		20	6.3	5.6	4.9
36	100		50	15.6	14.9	14.2
37	10	90	90	82.0	82.0	82.0
38		100	75	62.5	62.5	62.5
39	50	50	20	4.7	4.2	3.6
40	100		0	0.0	0.0	0.0
41	100		0	0.0	0.0	0.0
42	90	10	0	0.0	0.0	0.0
43	60	40	0	0.0	0.0	0.0
44	100		60	18.8	17.7	16.5

Table 2.6 (continued). EMISSIONS FROM NATURAL SURFACES IN RENO - 1975-80-85 (tons/year)

Grid	Percent soil type of entire grid		Percent natural surface of grid[c]	Total natural surface emission, ton/year		
	loamy[a]	gravelly[b]		1975	1980	1985
45	35	65	100	112.6	112.6	112.6
46		100	75	11.7	11.7	11.7
47		100	20	3.1	2.8	2.4
48		100	0	0.0	0.0	0.0
49		100	0	0.0	0.0	0.0
50		100	0	0.0	0.0	0.0
51	50	50	80	18.8	17.5	16.2
52		100	100	15.6	15.6	15.6
53		100	80	12.5	12.5	12.5
54		100	90	14.1	14.1	14.1
55		100	90	14.1	14.1	14.1
56		100	75	11.7	10.4	9.1
57	25	75	90	17.7	16.9	16.1
58		100	30	4.7	4.7	4.7
59		100	90	14.1	14.1	14.1
60		100	40	6.3	6.3	6.3
61		100	75	11.7	11.7	11.7

[a] Emission factor for loamy soil is 12 ton/mi^2/yr.

[b] Emission factor for gravelly soil is 6 ton/mi^2/yr.

[c] Percent natural surface assumed to be evenly distributed among the different soil types.

than estimate on which soil type the natural surfaces were located. The emission factors for each soil type were then factored by the percent of each soil type and the percent of natural surface in each grid. For example, in grid 24 in Reno:

Soil type	Emission factor ton/mi^2/year	Percent soil type	Resultant contribution ton/mi^2/yr
loamy	12	25	3.0
gravelly	6	75	4.5
	resultant emission factor	=	7.5
	percent natural surface		80
	total emission factor for grid 24	=	6.0 ton/mi^2/yr

Applying this factor to grid 24 which is 6 km on a side, the emissions are (6 km x 6 km)(0.3861 mi^2/km^2)(6.0 ton/mi^2/yr) = 83.4 ton/year. Care should be taken to make sure the proper grid size is used for each grid. The remaining grids were treated in a similar manner. For some grids, the emissions from natural surfaces in Reno decreased in 1980 and 1985. This was due to construction activity. The acreages that were developed due to construction were subtracted from the natural surface acres, then emissions were calculated as before.

Natural surface emissions (Table 2.6) were kept separate from all other inventory source categories, but were added to the inventory totals from Tables 2.1, 2.2, and 2.3 for modeling purposes.

REFERENCES FOR SECTION 2

1. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task C Report, Emission Inventory and Emission Projections. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. May, 1976.

2. Nevada Particulate Control Study for Air Quality Maintenance Areas Task B Report, Factors Influencing Emissions from Fugitive Sources. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. January, 1976.

3. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task A Report, Air Quality Monitoring Data. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. January, 1976.

4. Reno Folio Soil Map. Environmental Series. Nevada Bureau of Mines and Geology, University of Nevada. Reno, Nevada. 1973 data.

5. Reno Folio Land Use Map. Environmental Series. Nevada Bureau of Mines and Geology, University of Nevada. Reno, Nevada. 1974.

3. MODEL DESCRIPTION

To evaluate the impact of control strategies, it is necessary first to develop a relationship between emissions and air quality. Several diffusion modeling techniques have been suggested by the U.S. Environmental Protection Agency[1] for this purpose, including: Miller-Holzworth, AQDM, and Hanna-Gifford. The Hanna-Gifford approach was evaluated for applicability based on several reasons. The emission density vs. air quality relationship developed in the Task A Report[2] showed a reasonable correlation, but not high enough to be used to estimate air quality. The Hanna-Gifford simulation is a more sophisticated approach to emission density and air quality relationships and is expected to give a better correlation. Few major (tall stack) point sources are present in the study area. These sources would be evaluated poorly by Hanna-Gifford. This model best accomodates sources with low-level emission heights. This is typical of the source categories in the study area. Fugitive dust sources are generally ground level.

The basic model is an expression developed by S.R. Hanna and F.A. Gifford[3] to calculate the impact of various sources on a central receptor over a long period of time. The expression, the result of integrating the receptor-oriented Gaussian plume equation over upwind area sources (grids), is:

$$\chi = \sqrt{\frac{2}{\pi}}\,\frac{1}{u}\,\frac{(\Delta x/2)^{1-b}}{a(1-b)}\left\{Q_o + \sum_{i=1}^{n} Q_i\,\left[(2i+1)^{1-b} - (2i-1)^{1-b}\right]\right\}$$

where

χ = concentration in a grid, $\mu g/m^3$

u = wind speed, m/sec

Δx = grid width, m

a,b = stability coefficients ($a = 0.15$, $b = 0.75$ for urban areas)

Q_o = source strength of receptor grid, $\mu g/m^2$-sec

Q_i = source strength of i^{th} grid away from the receptor grid, $\mu g/m^2$-sec

n = number of grids in any one direction which will have a significant impact on the receptor grid for this study assume $n = 2$.

For an area marked off in grids of a given size, the quantity

$$\sqrt{\frac{2}{\pi}}\ \frac{(\Delta x/2)^{1-b}}{a(1-b)} = \text{constant} = C$$

For a 2 km grid, $\Delta x = 2000$ m and $C = 119.6$.

For a 6 km grid, $\Delta x = 6000$ m and $C = 157.5$.

It was assumed that the air quality of each receptor grid is affected not only by the emissions of that grid but also by the emissions from two rings of surrounding source grids. The quantity within the square brackets [ ] in the first equation expresses the relative contribution of these emissions based on distance in terms of number of grids (i) away from the receptor. This scheme has been modified for this study by assuming that the impact of the source grid emissions on a receptor grid is proportional to the distance between the centers of these grids in relative grid widths.

In the original model, for each grid in the ring of grids nearest the receptor the relative impact of the emissions is the same, since for each of these grids $i = 1$. In the modified version $i = 1.00$ for grids which have a side in common with the receptor grid. However, for grids which lie on the diagonal of the central grid, i = 1.41. Consequently, emissions from these grids have a lesser impact than those from grids having a common side with the receptor.

Note, the grid sizes cannot be mixed. Impact on a receptor must be calculated from source grids of an equivalent size. Therefore, in order to estimate air quality in those 2 km grids which are nearest the 6 km grids, it was necessary to create two rows of artificial 2 km grids whose emissions were fractional parts of the emissions of the corresponding 6 km grids. Two rows of artificial 6 km grids must, likewise, be created around the entire grid network. Since an emission inventory for these areas does not exist, the emissions of the perimeter grids were repeated. This appears to be a valid assumption in light of the fact that the two areas, gridded and non-gridded, have a similar makeup, and that if these areas were assumed to have zero emissions the air quality impact might be severly underestimated. Also, within the central part of the grid system, artificial 6 km grids were composed of combinations of 2 km grids.

Meteorological conditions will also have an effect on air quality. The impact of the emissions from each source grid was weighted based on the frequency of occurrence of the wind out of the direction that grid lies from the receptor. Wind speed was also varied with wind direction. Historical data[4] and a sixteen-point compass were used.

The emission inventory data presented in Tables 2.1 and 2.6 were used to calibrate the model. Measured annual geometric mean concentrations were correlated against the modeled air quality at each of the nine sampling stations in Reno. Very few sampling stations were located at the center of a grid. Therefore, the modeled air quality was obtained by weighting the modeled impact from each grid which at least partially occupies an imaginary grid of equal size having a sampling site at its center. The grids at each sampling site, their allocation factors, and the results of this correlation procedure are shown in Table 3.1. Correlation results (0.79) show that the Hanna-Gifford approach is an acceptable diffusion model to use in this study. The slope and intercept are the parameters required to calibrate the model for comparison to actual data. Subsequent model runs predict air quality concentrations according to the following expression:

predicted air quality = (0.617)(modeled air quality) + 25.4

The value 25.4 may also be looked upon as a background concentration which is unaccounted for by any other source of emissions. This value is considered to be an acceptable background value by the Washoe County District Health Department. It is also in good agreement with the intercept from the emission density versus air quality correlation presented in the Task A report.[5]

Table 3.1. CORRELATION OF RENO ANNUAL GEOMETRIC MEANS WITH MODELED AIR QUALITY

Site	Grids	Uncalibrated model impact $\mu g/m^3$	Allocation factors	Grid contribution $\mu g/m^3$	Modeled air quality at site $\mu g/m^3$	Measured annual geometric mean[b] $\mu g/m^3$
A, Washoe County Health Dept.	41	81.4	7/9	63		
	42	115.0	2/9	26	89	77
B, Cal-Neva Club	40	50.6	1/3	17		
	41	81.4	2/3	54	71	74
C, Jessie Beck School	26	18.1	2/9	4		
	32	35.3	6/9	23		
	33	62.3	1/9	7	34	44
D, Reno Airport	28	26.1	2/9	6		
	34	40.1	6/9	27		
	35	19.6	1/9	2	35	65
E, Nevada Fish and Game	41	81.4	1/3	27		
	48	51.8	2/3	35	62	57
F, Mamie Towles School	39	32.9	1/2	17		
	46	40.5	1/2	20	37	32
G, Greenbrae School	51	39.0	1/1	39	39	58
H, Sparks Nugget[a]	43	39.1	5/9	21		
	44	61.3	1/9	7		
	50	38.6	3/9	13	41	90
J, Verdi School	16	10.5	1/2	5		
	37	13.1	1/2	7	12	16
L, Sewer Plant	24	19.2	1/2	10		
	45	22.6	1/2	11	21	50
Correlation						0.793
Slope						0.617
Intercept						25.360

[a] Site H was not included in the correlation because of an apparent sampling site bias.

[b] Calculated using October 1974 thru September 1975 data.

REFERENCES FOR SECTION 3

1. Guidelines for Determining the Need for Plan Revisions to the Control Strategy Portion of the Approved State Implementation Plan. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. OAQPS No. 1.2-011 (Revision).

2. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task A Report, Air Quality Monitoring Data. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. January, 1976.

3. A Simple Method of Calculating Dispersion from Urban Area Sources. Steven R. Hanna, Journal of the Air Pollution Control Association. December 1971.

4. National Climatic Center, U.S. Department of Commerce. Asheville, North Carolina.

5. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task A Report, Air Quality Monitoring Data. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. January, 1976.

4. MODELED AIR QUALITY

The 1975 Reno air quality, as determined by the model described in Section 3, is shown in Figure 4.1. The air quality in $\mu g/m^3$ is indicated in each grid by an encircled number. Figure 4.2 is a similar diagram showing projected 1985 air quality. A slight increase in modeled concentrations can be observed in all grids except one. This result might be expected based on increased emissions due to growth from 1975 to 1985. The decrease in concentration in grid 42 is observed because a major emission source in that grid (a large sand and gravel pit operation) will not be present in 1985. As shown in Task F, particle size distributions were determined from glass fiber filter samples at three sites in Reno. The average percent by weight of all particles less than 5.3 μm, assumed to be the particle size cutoff for respirable material, was calculated to be 7.4 percent. By multiplying all 1975 modeled concentrations by this percentage, the concentration of respirable material in the ambient air in 1975 is obtained. These respirable concentrations are shown in Figure 4.3.

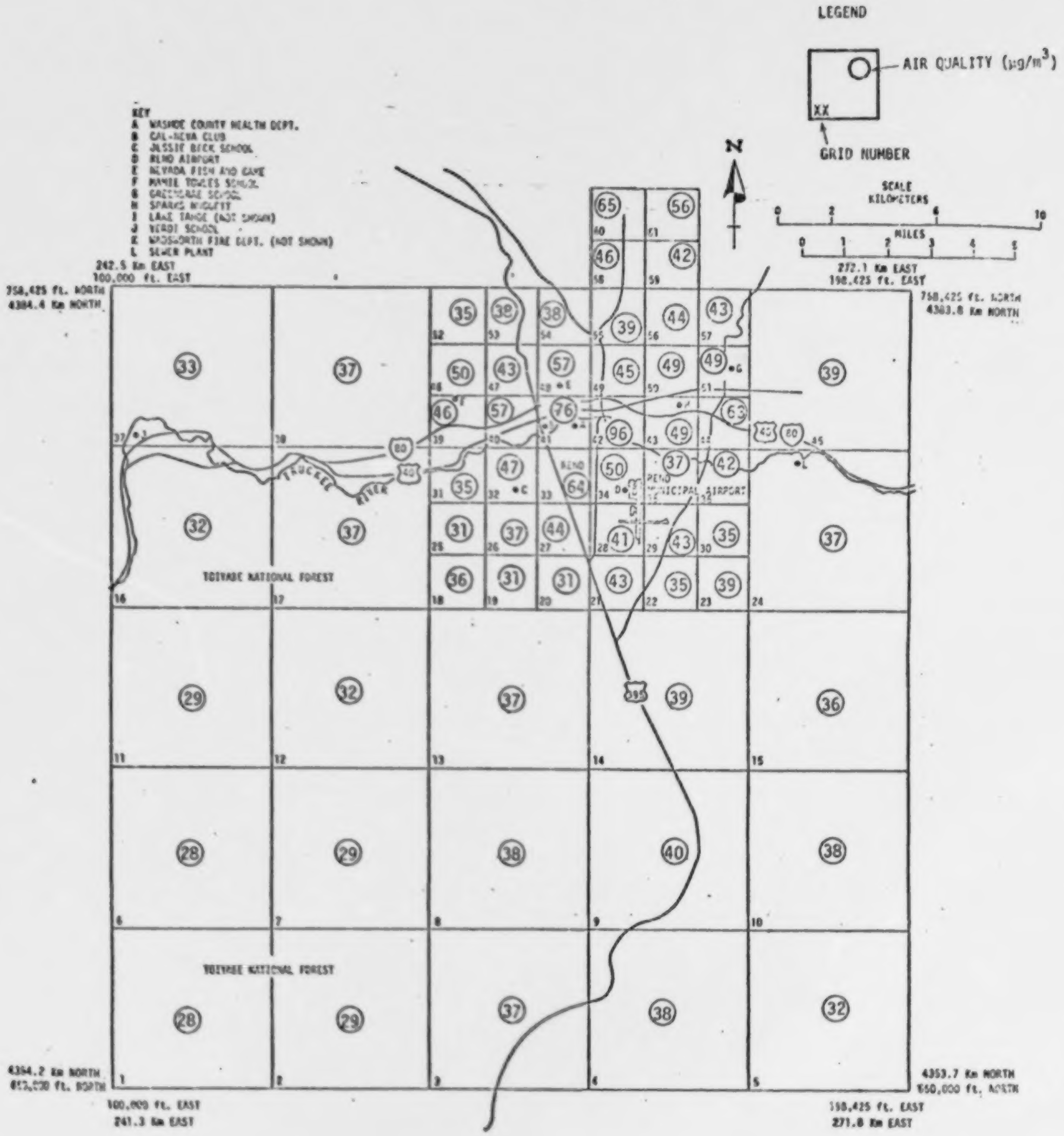
LEGEND
AIR QUALITY (μg/m³)
XX
GRID NUMBER
N
SCALE
KILOMETERS
0 2 6 10
MILES
0 1 2 3 4 5
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS MCGUFFY
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
242.5 Km EAST
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
272.1 Km EAST
198,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
TRUCKEE RIVER
80
40
395
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
4354.2 Km NORTH
650,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
650,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST
65
56
46
42
33
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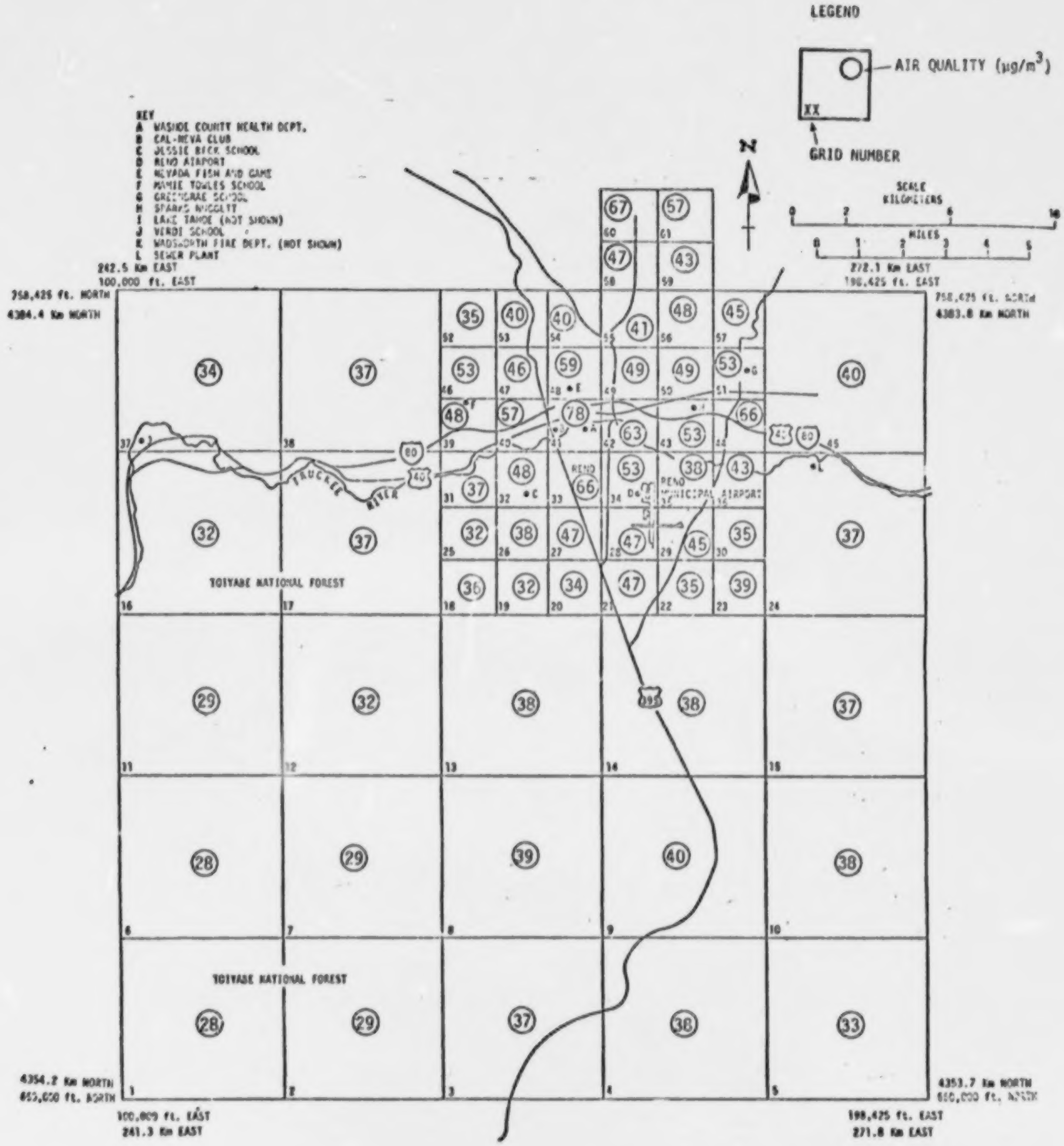
Figure 4.1 1975 Reno modeled air quality.


LEGEND
AIR QUALITY (μg/m³)
XX
GRID NUMBER
N
SCALE
KILOMETERS
0 2 6 10
MILES
0 1 2 3 4 5
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
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G GREENBRAE SCHOOL
H SPARKS NUGGETT
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242.5 Km EAST
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758,425 ft. NORTH
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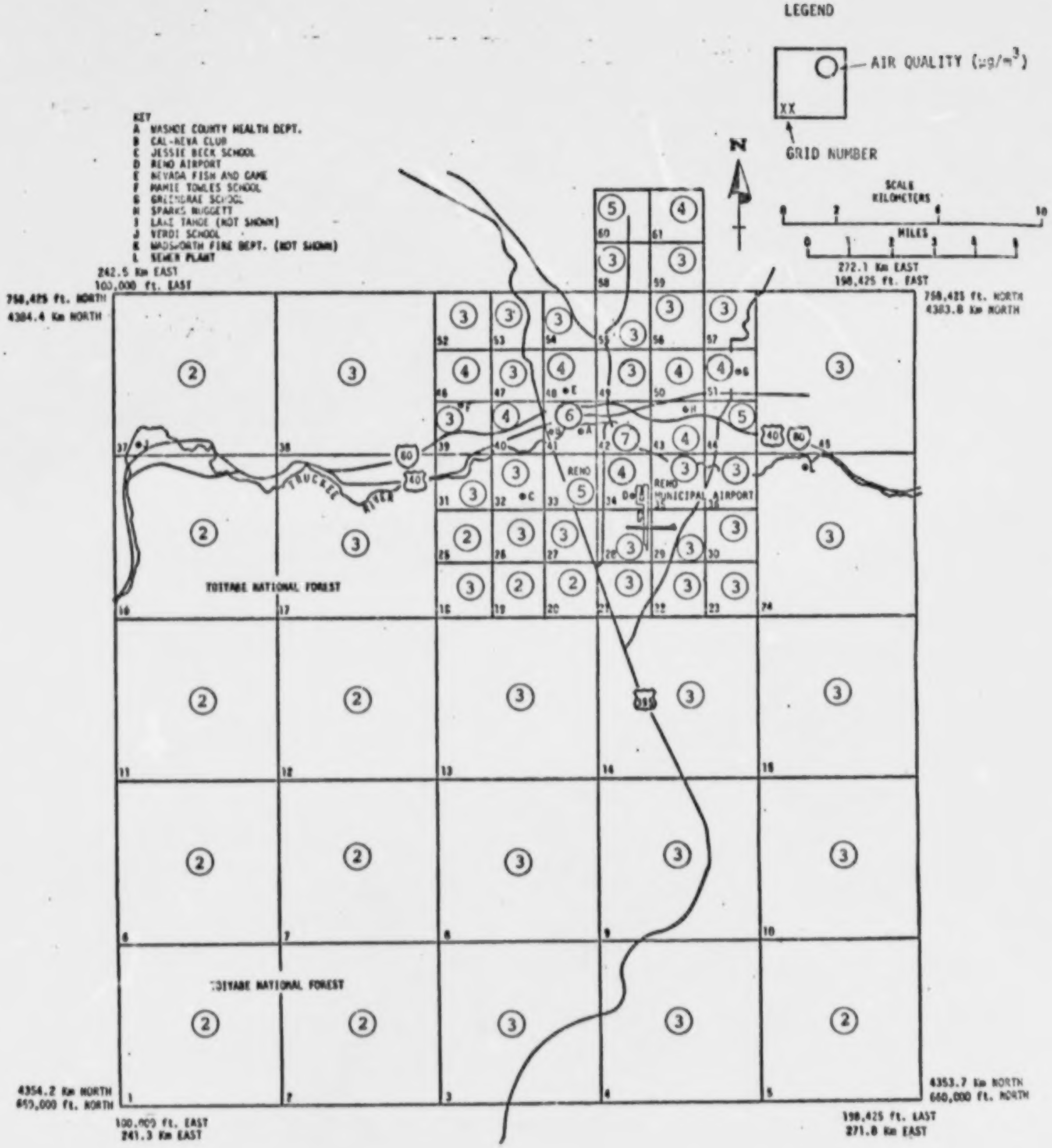
272.1 Km EAST
198,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
67 57
47 43
35 40 40 41 48 45
34 37 53 46 59 49 49 53 40
48 57 78 63 53 66
37 48 66 53 38 43
32 37 32 38 47 47 45 35 37
36 32 34 47 35 39
29 32 38 38 37
28 29 39 40 38
28 29 37 38 33
TRUCKEE RIVER
80
40
395
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
4354.2 Km NORTH
658,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
658,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST

Figure 4.2 1985 Reno modeled air quality.[a]

[a] Present emissions are based on existing programs. They do not include reductions attributable to control strategies described in Section 7.0.


LEGEND
AIR QUALITY (μg/m³)
XX
GRID NUMBER
N
SCALE
KILOMETERS
0
2
6
10
MILES
0
1
2
3
4
5
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
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242.5 Km EAST
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758,425 ft. NORTH
4383.8 Km NORTH
TRUCKEE RIVER
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
80
40
395
4354.2 Km NORTH
660,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST

Figure 4.3 1975 Reno modeled respirable air quality.

5. CONTROL STRATEGIES

Several control possibilities were discussed with Washoe County District Health Department, Air Pollution Control Division personnel. These strategies were designed to affect the major source categories in the study area. Initially, the following strategies were considered:

Street cleaning,
Stationary source control,
Control of construction emissions,
Reduction of unpaved road emissions, and
Reduction in emissions from controlled burning.

In discussions with the local agency, two of these strategies, stationary source control and reduction in emissions from controlled burning, were eliminated from further consideration. This was because the stationary source of principal concern would not be operating by 1985 and reduction in emissions from controlled burning is not considered feasible. The other strategies were evaluated by first determining the emission reduction efficiencies that are expected for each strategy. A weighing factor was then applied to better estimate the actual impact on air quality that each strategy will have. This is explained in Section 6. The resulting emissions were then input to the Hanna-Gifford model to predict the resultant air quality. These results are shown in Section 7.

STREET CLEANING

This control strategy involves a regular schedule of paved street cleaning using mobile vacuum cleaning equipment. Paved street cleaning is expected to reduce the reentrainment of particulates which have accumulated due to normal deposition year-round and street sanding in winter. The percent reduction in these emissions is calculated based on the following assumptions:

1) vacuum sweeper removal efficiency is 75% on streets maintaining a maximum particulate loading,
2) particulates accumulate as shown in column 2 of Table 5.1,
3) streets will again attain maximum loading 7 days after cleaning,
4) streets will be cleaned every seven days.

Table 5.1 shows the calculations involved in determining an average percent reduction in paved street emissions. Since vacuum sweepers are not one-hundred percent efficient, a residual amount of particulates will remain on the streets after cleaning. In addition to any residual loading, particulates will accumulate as shown in column 2 of Table 5.1.[1] Total street loading (accumulation plus residual) will increase each day since the last cleaning, until a maximum or equilibrium loading is attained on the seventh day, after which the total loading remains constant. The residual loading is that amount which is never removed from the streets regardless of how often the streets are cleaned. Thus, only the additional accumulation is removed during cleaning. The maximum accumulation is expected to occur seven days after cleaning and will amount to 800 lb/curb-mile. The literature reports a vacuum sweeper efficiency of 95.3 percent.[2] However, this efficiency was determined under test conditions. Less than ideal conditions are often encountered in actual applications. Undulations in the pavement, such as sewer openings, and the detours street

Table 5.1 PERCENTAGE OF MAXIMUM STREET LOADING BY NUMBER OF DAYS SINCE CLEANING

Days since cleaning	Accumulation since cleaning, lb/curb-mile[a]	Residual loading, lb/curb-mile	Total street loading, lb/curb-mile	Average street loading, lb/curb-mile	Average loadings, percent of maximum	Percent reduction in maximum loading due to cleaning
1	175	270	445	445	42	58
2	325	270	595	520	49	51
3	425	270	695	578	54	46
4	525	270	795	633	59	41
5	625	270	895	685	64	36
6	700	270	970	733	69	31
7	800	270	1070	780	73	27
8	800	270	1070	817	76	24
9	800	270	1070	845	79	21
10	800	270	1070	868	81	19

Based on vacuum cleaner removal efficiency of 75% and removal of maximum accumulation of 800 lb/curb-mile, the residual loading is calculated by ratio to be (800 lb/curb-mile removed) (25% residual/75% removed) = 270 lb/curb-mile which remains constant. Accumulation and, therefore, total street loading will increase each day since the last cleaning until a maximum or equilibruim loading (maximum accumulation plus residual) of 800 + 270 = 1070 lb/curb-mile is attained on the seventh day, after which the total loading remains constant.

For a 7 day cleaning cycle:

Average daily loading = (445 + 595 + 695 + 795 + 895 + 970 + 1070)/7 = 780 lb/curb-mile
Percent of maximum loading = (780/1070) x 100% = 73%
Reduction in loading = 100% (maximum loading) - 73% of maximum loading due to 7 day cleaning cycle = 27%
Percent emission reduction = 27%

[a] Reference 1.

cleaners must take to avoid parked cars are expected to reduce the cleaning efficiency to 75 percent. Therefore, the maximum or equilibrium loading (maximum accumulation plus residual) is calculated by dividing the amount removed during cleaning (maximum accumulation) by the efficiency of the street cleaner itself. Thus, the maximum loading is

$$\frac{800 \text{ lb/curb-mile}}{\text{efficiency, } 0.75} \simeq 1070 \text{ lb/curb-mile}$$

The residual loading (maximum minus accumulation) is, therefore, 1070-800=270 lb/curb-mile which is never removed from the street.

In Table 5.1, the total loading by number of days since cleaning (column 4) is the sum of the accumulation by day (column 2) plus the residual (column 3). The average street loading (column 5) is the average of the total street loadings for each number of days since the last cleaning. If the streets were never cleaned again, the average loading would eventually reach a maximum of 1070 lb/curb-mile. Column 6 shows the average percent of maximum loading which the streets would maintain due to a cleaning cycle of each given number of days. The reduction from the maximum loading is shown in column 7. For example, if the streets were cleaned every three days the average loading would be (445 + 595 + 695)/3 = 578 lb/curb-mile, or (578/1070) x 100% = 54 percent of the maximum loading. Conversely, the percent reduction in the loading is 100-54 = 46 percent. The reduction in street loading is directly proportional to the reduction in fugitive dust emissions from paved streets. Therefore, a 46 percent reduction in the street loading results in a 46 percent reduction in emissions. Similarly, a 7-day cleaning cycle has an average loading of 780 lb/curb-mile, or 73 percent of the maximum loading, and results in a 27 percent reduction in emissions. For the implementation of this control strategy a conservative estimate of the average removal efficiency of 25 percent was used due to the inaccuracies involved in the development of the accumulations shown in column 2 of Table 5.1.

The Nevada State Highway Department has designated eight road classifications: local, minor arterial, major arterial, collector, ramp, interstate, freeway, and expressway. Of these only the first four types are subject to street cleaning. Since emissions are based on VMT, only emissions due to the percentage of travel on these four road types will be affected. Street cleaning operations will not extend beyond the city limits of Reno and Sparks. Therefore, emissions from rural grids will not change.

The 25 percent average removal efficiency is also applied to all emissions from street sanding.

It was assumed that the curb or shoulder lane on each side of all paved roads is to be cleaned. The total number of miles to be cleaned within the boundaries described above is:[4]

$$\begin{array}{lrl} \text{Reno} & 700 & \\ \text{Sparks} & \underline{108} & \\ & 800 & \text{paved street miles} \\ & \underline{\times 2} & \text{directions} \\ & 1{,}616 & \text{cleaned miles} \end{array}$$

It was also assumed that a single cleaner could treat 30 miles of pavement per day. Therefore, in order to clean all pavement once a week, the number of cleaners required is

$$1{,}616\ \frac{\text{miles cleaned}}{\text{week}} \times \frac{\text{day}}{\text{30 miles cleaned}} \times \frac{\text{week}}{\text{7 days}} \simeq 8 \text{ cleaners}$$

The capital cost[5] of 8 cleaners at $45,000 per cleaner is $360,000. Operating and maintenance costs are $1.05 per mile.[4] Thus, assuming cleaning operations are conducted 50 weeks out of the year, annual operating cost for the 8 cleaners is

$$1{,}616\ \frac{\text{miles cleaned}}{\text{week}} \times \frac{1.05}{\text{mile cleaned}} \times \frac{50\ \text{weeks}}{\text{year}} = \$84{,}840.$$

CONSTRUCTION SITE WATERING

This control strategy involves the reduction of emissions from haul roads on construction sites. Watering is expected to reduce these emissions by 50 percent during periods of active construction.[3] Chemical stabilization methods were not considered for this strategy since many stabilizers cannot withstand traffic, and since windblown emissions, which chemical stabilizers are designed to control, are small compared to emissions from excavation and regrading activity. This strategy was applied to all grids where construction was expected to occur in 1985 based on projections provided by the Regional Planning Commission of Reno, Sparks, and Washoe County.

The 50 percent reduction is achieved by watering twice daily at a cost rate of $2-5/acre-day.[3] Based on the acreage used in the Task C Report[6] to calculate emissions, the total number of active acre-days is:

Residential = 105 acres x 90 days active = 9,450 acre-days
Commercial = 53 acres x 180 days active = 9,540 acre-days
Industrial = 0.25 acres x 240 days active = 60 acre-days
Total = 19,050 acre-days

The total cost is, therefore, $38,100 to $95,250 annually.

ROAD PAVING

Emissions from unpaved roads may be reduced by means of an annual paving schedule. The area affected by this control strategy is that within the city limits of Reno and Sparks. It was assumed that an 85 percent reduction in emissions from those roads which would be paved could be achieved.[3]

The road pavement is assumed to be a 3-inch bituminous surface without curbs. The cost of this material is $20,000-26,000 per mile.[3] (Note that this information is rather dated, 1972, and better estimates could be obtained by consulting local contractors.) The total cost of paving 2.3 miles of unpaved roads within the urban area would be $46,000 to $60,000.

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6. WEIGHING FACTOR

In attempt to estimate more closely the impact on air quality that will be expected from emission reductions, development of a weighing factor was investigated in the Task F Report, Particulate Characterization Study.[1] This factor was developed because of the disparity observed between the percent mineral observed on hi-volume sampler filters and the percent mineral emissions in the microinventories surrounding the hi-vol site. A much higher percent of the emissions were mineral than were collected on the filters. Therefore, a reduction in mineral emissions cannot be expected to result in an equal reduction in filter loading.

From the microinventory of selected sites in Reno and Sparks, shown in Tables 6.1, 6.2 and 6.3, all emissions were identified and classified as being from mineral, tire wear, or combustion sources. Also, high volume samples (millipore and glass fiber), which were taken at these sites, were analyzed under Task F for the percent by weight of material from the same source classifications. The mineral percentage by weight of both the emissions and the filter loadings are shown in Table 6.4.

It has been observed that a high percentage of all microinventory emissions at the selected sites are from mineral sources. One would expect a similar percentage of minerals to appear on the sample filters. This, however, was not the case. On the average, the sample fitlers showed a percentage of mineral impact which was only 60 percent of

Table 6.1. MICROINVENTORY OF PARTICULATE EMISSIONS AT CAL-NEVA CLUB SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	2.6 acres	0.2-0.3 ton/ac/yr[a]	0.7		
Unpaved roads	8.0 VMT/day	3.9 lb/VMT	5.7		
Normal paved roads	452,233 VNT/day	1.75 gm/VMT	255.9		
Unpaved parking lots	1.5 VMT/day	1.6 lb/VMT	0.4		
R.R. right of ways and yards	10.4 acres	0.2 ton/ac/yr	2.0		
Agriculture	16.3 acres	windblown 5.36 lb/ac/yr tilling 280 lb/ac/yr	2.3		
Sand on streets for snow control			22.8		
Stationary area source fuel combustion					52.5
Fireplaces					26.7
Motor vehicles[b]	452,233 VMT/day	0.0013 lb/VMT		42.9	64.4
Railroads	189,690 gal/yr	0.025 lb/gal			2.4
Total			289.8	42.9	146.0
Percent of total			61	9	30

[a] Range of emission factors used. Factors vary soil type, vegetative cover, traffic, and stabilization.

[b] Assume 60 percent of emissions due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table 6.2. MICROINVENTORY OF PARTICULATE EMISSIONS AT SPARKS NUGGET SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Active construction	22.4 acre-months	1.0 ton/ac/mo	22.6[a]		
Cleared areas	4.4 acres	0.2-0.24 ton/ac/yr[b]	1.0		
Playground	4.8 acres	1.5 ton/ac/yr	7.2		
Unpaved roads	40 VMT/day	3.9 lb/VMT	28.5		
Normal paved roads	149,083 VMT/day	1.75 gm/VMT	84.4		
Unpaved parking lots	4.5 acres	0.65 ton/ac/yr	3.0		
R.R. right of ways and yards	84.2 acres	0.2 ton/ac/yr	16.8		
Heavy equipment storage	2.2 acres	0.32 ton/ac/yr	0.7		
Dirty paved roads	2,266 VMT/day	28 gm/VMT	20.5		
Stationary area source fuel combustion					25.2
Fireplaces					37.0
Motor vehicles[c]	151,349 VMT/day	0.0013 lb/VMT		14.4	21.5
Railroads	256,266 gal/yr	0.025 lb/gal			3.2
Point source			0.2		
Total			184.9	14.4	86.9
Percent of total			65	5	30

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Assume 60 percent of emissions due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table 6.3. MICROINVENTORY OF PARTICULATE EMISSIONS AT WASHOE COUNTY HEALTH DEPARTMENT SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	9.8 acres	0.18-0.82 ton/ac/yr[a]	2.5		
Playground	1.7 acres	1.5 ton/ac/yr	2.6		
Unpaved roads	333 VMT/day	3.1-4.7 lb/VMT[b]	198.8		
Normal paved roads	428,101 VMT/day	1.75 gm/VMT	242.3		
Sand and gravel pits	60.0 acres	1.9 ton/ac/yr	114.0		
Unpaved parking lots	1.9 VMT/day	1.6 lb/VMT	0.6		
R.R. right of ways and yards	10.4 acres	0.2 ton/ac/yr	2.0		
Heavy equipment storage	6.6 acres	0.32 ton/ac/yr	2.1		
Agriculture	16.3 acres	windblown 5.36 lb/ac/yr tilling 280.0 lb/ac/yr	2.4		
Sand on streets for snow control			21.6		
Stationary area source fuel combustion					52.5
Fireplaces					26.7
Motor vehicles[c]	428,101 VMT/day	0.00013 lb/VMT		40.6	61.0
Railroads	187,183 gal/yr	0.025 lb/gal			2.3
Point source			19.0		
Total			607.9	40.6	142.5
Percent of total			77	5	18

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Range of emission factors used. Factors vary by vehicle speed.

[c] Assume 60 percent of emissions due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table 6.4. FUGITIVE DUST WEIGHING FACTOR

Site	Microinventory emissions, percent mineral	Glass fiber filters, percent mineral	Reduction ratio,[a] $\frac{\text{Glass fiber}}{\text{Microinventory}}$	Millipore filters, percent mineral	Reduction ratio,[a] $\frac{\text{Millipore}}{\text{Microinventory}}$
Cal-Neva Club	61	38	0.63	33	0.55
Sparks-Nugget	65	43	0.67	32	0.50
Washoe Health Dept.	77	41	0.53	51	0.66
Average			0.61		0.57

Overall Average Reduction Ratio 0.59[b]

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[a] Ratio of percent mineral collected on the hi-vol filter divided by the percent mineral emissions in the microinventory at the hi-vol site.

[b] For this study, the reduction ratio (weighing factor) was rounded to 0.60, as agreed to by the Washoe County District Health Department.

the percentage of mineral emissions. Therefore, reductions in mineral emissions and reductions in ambient air quality are not expected to occur in a one-to-one ratio.

Since the control strategies described in Section 5 are applied to mineral emissions, only 60 percent of any reduction in emissions due to the control strategies will be observed in the ambient air quality as measured by the high volume sampler. Therefore the weighing factor will be applied as follows:

Control strategy reduction, percent
times
Weighing factor, 0.60
equals
Effective percent reduction

Table 6.5 shows the effective reduction in emissions for each control strategy described in Section 5 due to the application of the 60 percent weighing factor. The effective percent reduction is then applied to each applicable emission category to generate the emissions that are input to the Hanna-Gifford model for strategy evaluation. This is as follows:

Affected category emission (by grid)
times
effective percent reduction
equals
reduction in category emissions (by grid)

Total category emissions (by grid)
minus
reduction in category emissions (by grid)
equals
emissions input to control strategy evaluation.

For each source category which is affected by a control strategy, Table 6.6 shows the 1985 emissions by grid both before and after application of the control strategy. The reduction in emissions by grid due to the application of the strategy is also shown. Use of the factors shown in Table

Table 6.5. EFFECTIVE EMISSION REDUCTIONS DUE TO CONTROL STRATEGY

Control strategy	Percent reduction	Weighing factor	Effective percent reduction
Street cleaning	25	0.6	15
Construction site watering	50	0.6	30
Road paving	85	0.6	51

Table 6.6 1985 RENO CONTROL STRATEGY EMISSIONS BY GRID (tons/year)

Grid	Street cleaning						Stabilization of construction areas			Road paving		
	Normal paved streets			Street sanding			Construction			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
1												
2												
3	33.0	33.0					0.8	0.56	0.24	162.0	162.0	
4	2.0	2.0					0.8	0.56	0.24	205.0	205.0	
5										65.0	65.0	
6												
7										11.0	11.0	
8	29.7	29.7					6.6	4.6	2.0	258.0	258.0	
9	44.9	44.9					15.5	10.9	4.6	205.0	205.0	
10	3.6	3.6								226.0	226.0	
11												
12										108.0	108.0	
13	26.1	26.1					12.6	8.8	3.8	129.0	129.0	
14	58.6	58.6					101.2	70.8	30.4	86.0	86.0	
15	1.9	1.9								162.0	162.0	
16	51.9	51.9					7.2	5.0	2.2	86.0	86.0	
17	51.1	51.1					12.9	9.0	3.9	258.0	258.0	
18	1.7	1.4	0.3							43.0	43.0	
19	4.0	3.4	0.6				7.2	5.0	2.2			
20	17.3	15.0	2.3									
21	39.0	34.9	4.1				60.3	42.2	18.1			
22	7.7	7.1	0.6				14.4	10.1	4.3			
23	1.7	1.7					27.2	19.0	8.2	22.0	22.0	

Table 6.6 (continued). 1985 RENO CONTROL STRATEGY EMISSIONS BY GRID

(tons/year)

Grid	Street cleaning						Stabilization of construction areas			Road paving		
	Normal paved streets			Street sanding			Construction			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
24	3.8	3.8					4.4	3.1	1.3	194.0	194.0	
25	4.4	4.2	0.2				7.2	5.0	2.2			
26	5.6	5.1	0.5	1.0	0.9	0.1	28.2	19.7	8.5			
27	54.2	48.1	6.1	8.5	7.2	1.3	20.3	14.2	6.1			
28	40.5	34.4	6.1	4.0	3.4	0.6	26.3	18.4	7.9			
29	8.5	7.6	0.9				27.2	19.0	8.2			
30	5.3	5.3					27.2	19.0	8.2			
31	12.5	11.0	1.5	1.4	1.2	0.2	11.6	8.1	3.5			
32	35.3	30.0	5.3	7.2	6.1	1.1	20.0	14.0	6.0			
33	105.7	89.2	16.5	18.8	16.0	2.8	30.3	21.2	9.1			
34	53.8	45.7	8.1	6.3	5.4	0.9	13.8	9.7	4.1	9.0	4.4	4.6
35	8.3	7.1	1.2				20.0	14.0	6.0			
36	6.4	6.4					20.0	14.0	6.0			
37	3.7	3.7					11.6	8.1	3.5	179.0	179.0	
38	4.2	4.2					7.2	5.0	2.2	323.0	323.0	
39	33.1	31.3	1.8	4.9	4.2	0.7	20.5	14.4	6.1	9.0	4.5	4.5
40	89.5	77.5	12.0	17.8	15.1	2.7	14.9	10.4	4.5			
41	193.9	169.0	24.9	35.2	29.9	5.3	12.7	8.9	3.8	6.0	2.8	3.2
42	118.3	104.5	13.8	17.9	15.2	2.7	13.0	9.1	3.9	27.0	13.4	13.6
43	57.3	51.5	5.8				19.9	13.9	6.0			
44	20.8	19.1	1.7				33.4	23.4	10.0	170.0	170.0	
45	29.0	29.0					7.2	5.0	2.2	75.0	75.0	
46	10.6	9.0	1.6	0.4	0.3	0.1	11.3	7.9	3.4	108.0	108.0	

Table 6.6 (continued). 1985 RENO CONTROL STRATEGY EMISSIONS BY GRID

(tons/year)

Grid	Street cleaning						Stabilization of construction areas			Road paving		
	Normal paved streets			Street sanding			Construction			Unpaved roads		
	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emissions due to Strategy	Reduction in Emissions	1985 base Emissions	Emission due to Strategy	Reduction in Emissions
47	36.1	30.7	5.4	4.9	4.2	0.7	20.7	14.5	6.2	2.0	0.9	1.1
48	34.0	29.0	5.0	5.0	4.3	0.7	17.7	12.4	5.3	60.0	29.3	30.7
49	55.8	49.2	6.6	6.7	5.7	1.0	15.1	10.6	4.5			
50	28.9	24.6	4.3				38.3	26.8	11.5			
51	7.9	6.7	1.2				50.2	35.1	15.1	28.0	14.0	14.0
52										22.0	22.0	
53	15.7	13.9	1.8				2.6	1.8	0.8	22.0	22.0	
54	11.4	11.4					5.0	3.5	1.5	22.0	22.0	
55	23.8	22.0	1.8				3.5	2.5	1.0			
56	17.3	15.5	1.8				73.7	51.6	22.1			
57	7.5	6.5	1.0				35.8	25.1	10.7	22.0	22.0	
58	1.2	1.2					21.1	14.8	6.3	86.0	86.0	
59	1.1	1.1					7.2	5.0	2.2	57.0	57.0	
60	2.1	2.1					21.1	14.8	6.3	229.0	229.0	
61	1.0	1.0					21.1	14.8	6.3	157.0	157.0	
Tot.	1522.7	1377.9	144.8	140.0	119.1	20.9	1008.0	705.3	302.7	3833.0	3761.3	71.7

6.5 for the development of Table 6.6 is illustrated in the following examples.

Street cleaning - Fugitive dust from normal paved roads is one of the source categories affected by street cleaning. It was assumed that of the eight functional road classifications in Nevada - local street, minor arterial, major arterial, collector, ramp, interstate, freeway, and expressway - only the first four are subject to street cleaning. In grid 42, 78 percent of the total VMT is on these four road types. Therefore, 78 percent of the emissions are affected by street cleaning. Table 6.5 shows that cleaning will reduce emissions by 15 percent. Since emissions in 1985 are projected to be 118.3 tons/year in grid 42, the reduction in emissions due to street cleaning would be (118.3)(0.78)(0.15) = 13.8 tons/year. Emissions due to the application of the strategy are, therefore, 118.3 - 13.8 = 104.5 tons/year.

Note that the strategy of street cleaning is to be applied only within the city limits of Reno and Sparks. Since grid 42 is entirely within the city limits, 100 percent of the emissions from the four specified road types is subject to control. However, this should be compared to grid 55. Although 98 percent of the emissions are from the four specified road types, only 50 percent of these occur within the boundaries of application of the control strategy. Thus, only 49 percent (98 x 0.50) of the emissions in grid 55 are affected by street cleaning rather than the full 98 percent. Since the 1985 emissions are projected to be 23.8 tons/year in grid 55, the reduction in emissions due to street cleaning would be (23.8)(0.49)(0.15) = 1.8 tons/year. Emissions due to the application of the strategy are, therefore, 23.8 - 1.8 = 22.0 tons/year.

Similarly, although grid 45 has emissions from the specified road types, none are within the control strategy boundaries of application, and, thus, are not subject to street cleaning. Therefore, no reduction in emissions due to this control strategy will be realized in grid 45. Street sanding is another source category which is affected by street cleaning. Since street sanding is done only within the city limits of Reno and Sparks, all fugitive dust emissions due to street sanding were reduced by 15 percent. For example, since the emissions in 1985 are projected to be 17.9 tons/year in grid 42, the reduction in emissions would be (17.9)(0.15) = 2.7 tons/year. Emissions due to the application of the strategy are, therefore, 17.9 - 2.7 = 15.2 tons/year.

Stabilization of construction areas - This strategy was applied to all grids where construction was expected to occur in 1985, based on projections provided by the Regional Planning Commission of Reno, Sparks, and Washoe County. As shown in Table 6.5, construction site watering will reduce emissions by 30 percent. For example, in grid 42, where the projected 1985 emissions from construction are 13.0 tons/year, the reduction in emissions would be (13.0)(0.30) = 3.9 tons/year. The emissions due to the application of the strategy are, therefore, 13.0 - 3.9 = 9.1 tons/year.

Road paving - Unpaved roads is the only source category affected by this strategy. Road paving will, as shown in Table 6.5, reduce the fugitive emissions from all unpaved roads within the city limits of Reno and Sparks by 51 percent. In grid 42, for example, the projected 1985 emissions are 27.0 tons/year. The reduction in emissions would be (27.0)(0.51) = 13.6 tons/year, and the resultant emissions due to the application of this strategy would be 27.0 - 13.6 = 13.4 tons/year. Emissions from all unpaved roads which are not within the city limits will remain unaffected.

REFERENCES FOR SECTION 6

1. Nevada Particulate Control Study for Air Quality Maintenance Areas: Task F Report, Particulate Characterization Study. PEDCo-Environmental Specialists, Inc., Cincinnati, Ohio. Prepared for the U.S. Environmental Protection Agency, Region IX, under Contract No. 68-02-1375, Task Order No. 29. August 1976.

2. Compilation of Air Pollutant Emission Factors. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. Publication No. AP-42. February 1976.

7. CONTROL STRATEGY RESULTS

Table 7.1 shows the projected 1985 TSP annualized air quality based on the projected inventory emissions. Next shown are the graphically-displayed reductions in air quality achieved by applying each control strategy to the 1985 uncontrolled emissions (Figures 7.1 through 7.3). The total reduction, due to the application of all control strategies, is shown in Figure 7.4.

According to the projections, only grid 41 in Reno in 1985 will be exceeding the primary National Ambient Air Quality Standards (NAAQS) of 75 $\mu g/m^3$. The source category of normal paved streets accounts for 59 percent of the emissions in grid 41. It is anticipated that the air quality standards can be met in this grid with the application of the proposed control strategy of street cleaning. This will lower the air quality from an estimated 78 $\mu g/m^3$ to approximately 73 $\mu g/m^3$.

The other strategies reduce the projected emissions, but only in grids that are already anticipated to be meeting the primary NAAQS. Therefore, the only strategy that need be considered for implementation is street cleaning.

Table 7.1. RENO CONTROL STRATEGY RESULTS AND REDUCTION, μg/m^3

	1985 Base	Street cleaning		Stabilization of const. areas		Road paving		All strategies applied	
Grid	Modeled air quality	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy
1	28	28		28		28		28	
2	29	29		29		29		29	
3	37	37		37		37		37	
4	38	38		38		38		38	
5	33	33		33		33		33	
6	28	28		28		28		28	
7	29	29		29		29		29	
8	39	39		39		39		39	
9	40	40		40		40		40	
10	38	38		38		38		38	
11	29	29		29		29		29	
12	32	32		32		32		32	
13	38	38		38		38		38	
14	38	38		38		38		38	
15	37	37		37		37		37	
16	32	32		32		32		32	
17	37	37		37		37		37	
18	36	36		36		36		36	
19	32	32		32		32		32	
20	34	34		34		34		34	
21	47	46	1	44	3	47		43	4
22	35	35		34	1	35		34	1
23	39	39		37	2	39		37	2
24	37	37		37		37		37	
25	32	32		32		32		32	
26	38	37	1	36	2	38		35	3
27	47	46	1	46	1	47		45	2
28	47	46	1	45	2	47		44	3
29	45	45		44	1	45		44	1
30	35	35		34	1	35		34	1
31	37	37		37		37		37	
32	48	47	1	46	2	48		45	3
33	66	63	3	64	2	66		61	5
34	53	51	2	51	2	52	1	48	5
35	38	38		37	1	38		37	1
36	43	42	1	41	2	42	1	39	4
37	34	34		34		34		34	
38	37	37		37		37		37	
39	48	48		47	1	48		47	1
40	57	55	2	56	1	57		54	3
41	78	73	5	77	1	77	1	71	7
42	63	61	2	62	1	61	2	58	5
43	53	52	1	52	1	53		51	2
44	66	65	1	64	2	66		63	3

Table 7.1 (continued). RENO CONTROL STRATEGY RESULTS AND REDUCTION, $\mu g/m^3$

	1985 Base	Street cleaning		Stabilization of const. areas		Road paving		All strategies applied	
Grid	Modeled air quality	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy	Modeled air quality	Reduction due to strategy
45	40	40		40		40		40	
46	53	53		53		53		53	
47	46	45	1	45	1	46		44	2
48	59	58	1	58	1	55	4	53	6
49	49	47	2	48	1	48	1	45	4
50	49	48	1	47	2	49		46	3
51	53	52	1	50	3	50	3	46	7
52	35	35		35		35		35	
53	40	40		40		40		40	
54	40	40		40		40		40	
55	41	41		41		41		41	
56	48	47	1	45	3	48		44	4
57	45	45		43	2	45		43	2
58	47	47		46	1	47		46	1
59	43	43		42	1	43		42	1
60	67	67		66	1	67		66	1
61	57	57		56	1	57		56	1

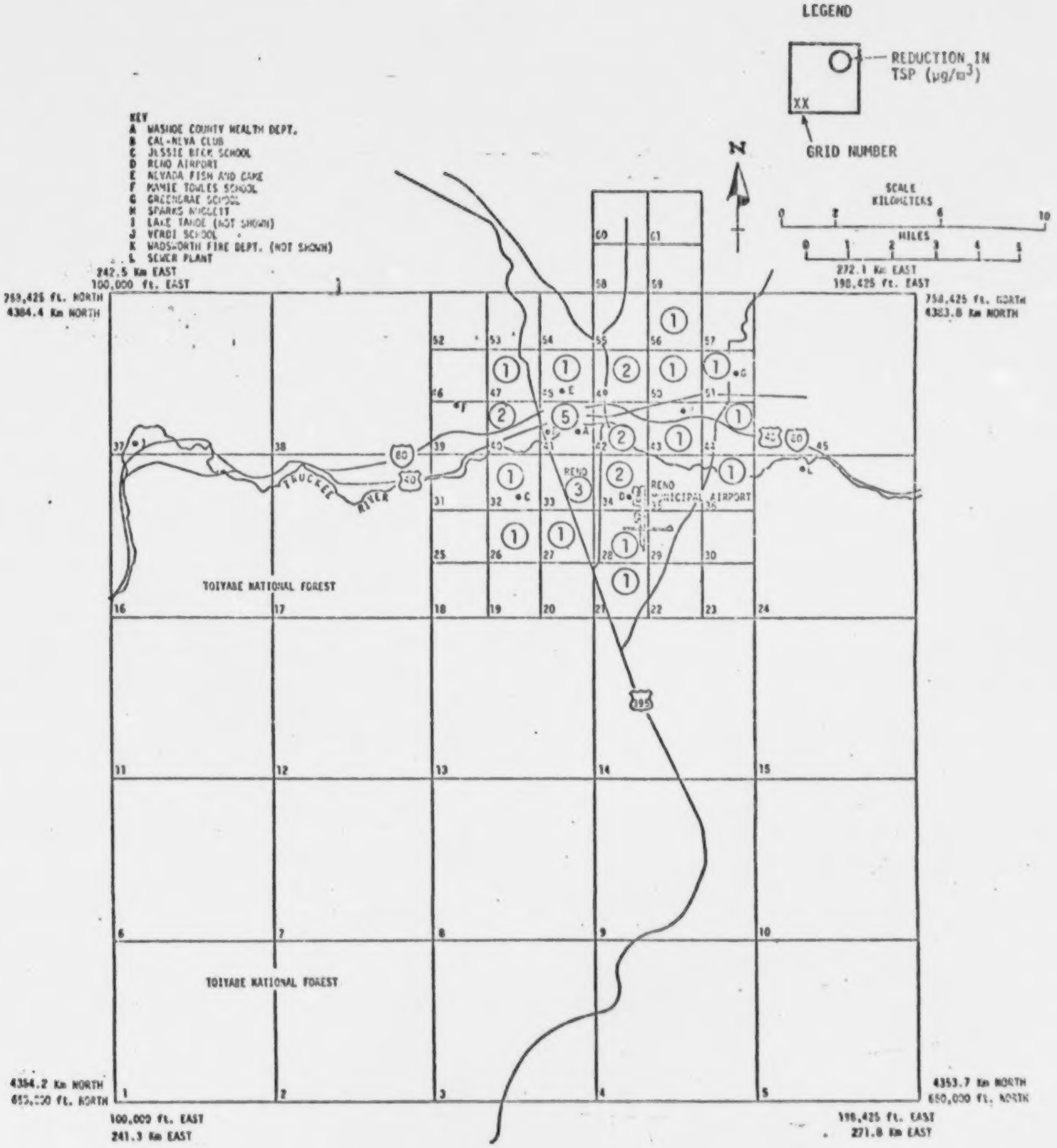

LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
N
SCALE
KILOMETERS
0 2 6 10
MILES
0 1 2 3 4 5
242.5 Km EAST
100,000 ft. EAST
753,425 ft. NORTH
4384.4 Km NORTH
272.1 Km EAST
198,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
4354.2 Km NORTH
650,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
650,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST
TRUCKEE RIVER
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
80
40
395

Figure 7.1 Change in 1985 Reno air quality due to street cleaning.

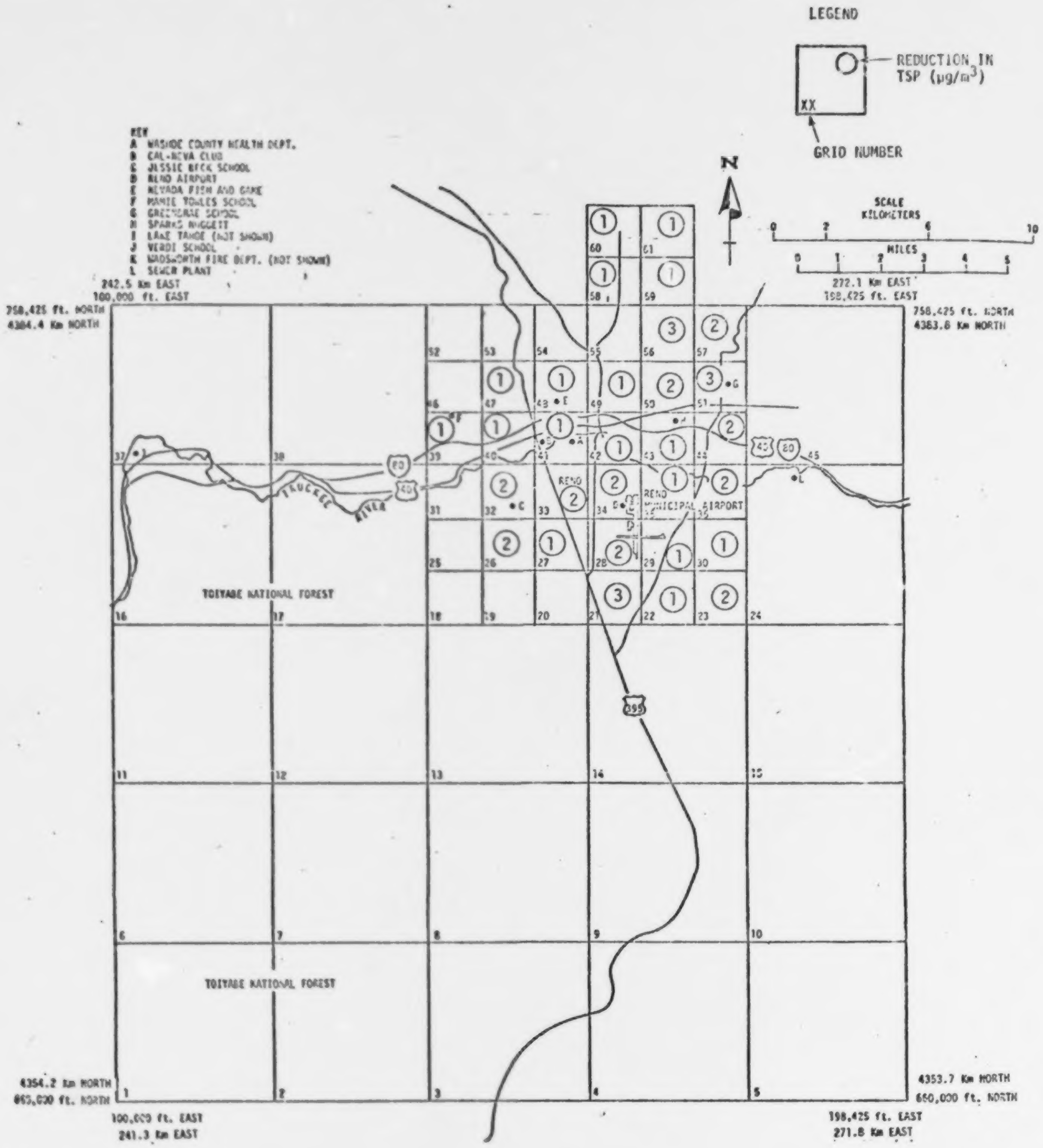

LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
N
SCALE
KILOMETERS
0 2 6 10
MILES
0 1 2 3 4 5
242.5 Km EAST
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
272.1 Km EAST
198,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
TRUCKEE RIVER
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
80
40
395
4354.2 Km NORTH
660,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST

Figure 7.2 Change in 1985 Reno air quality due to stabilization of construction areas.

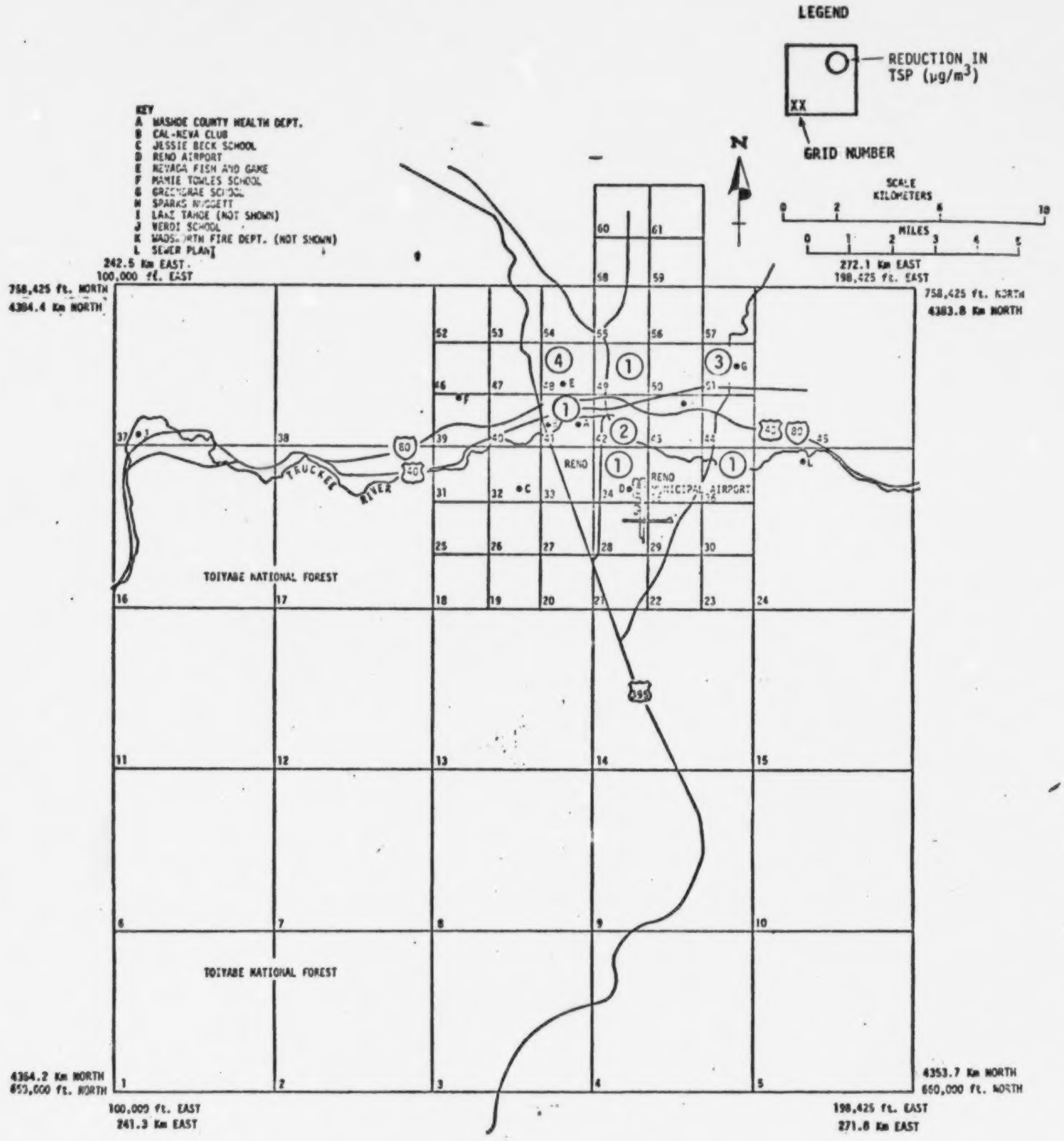
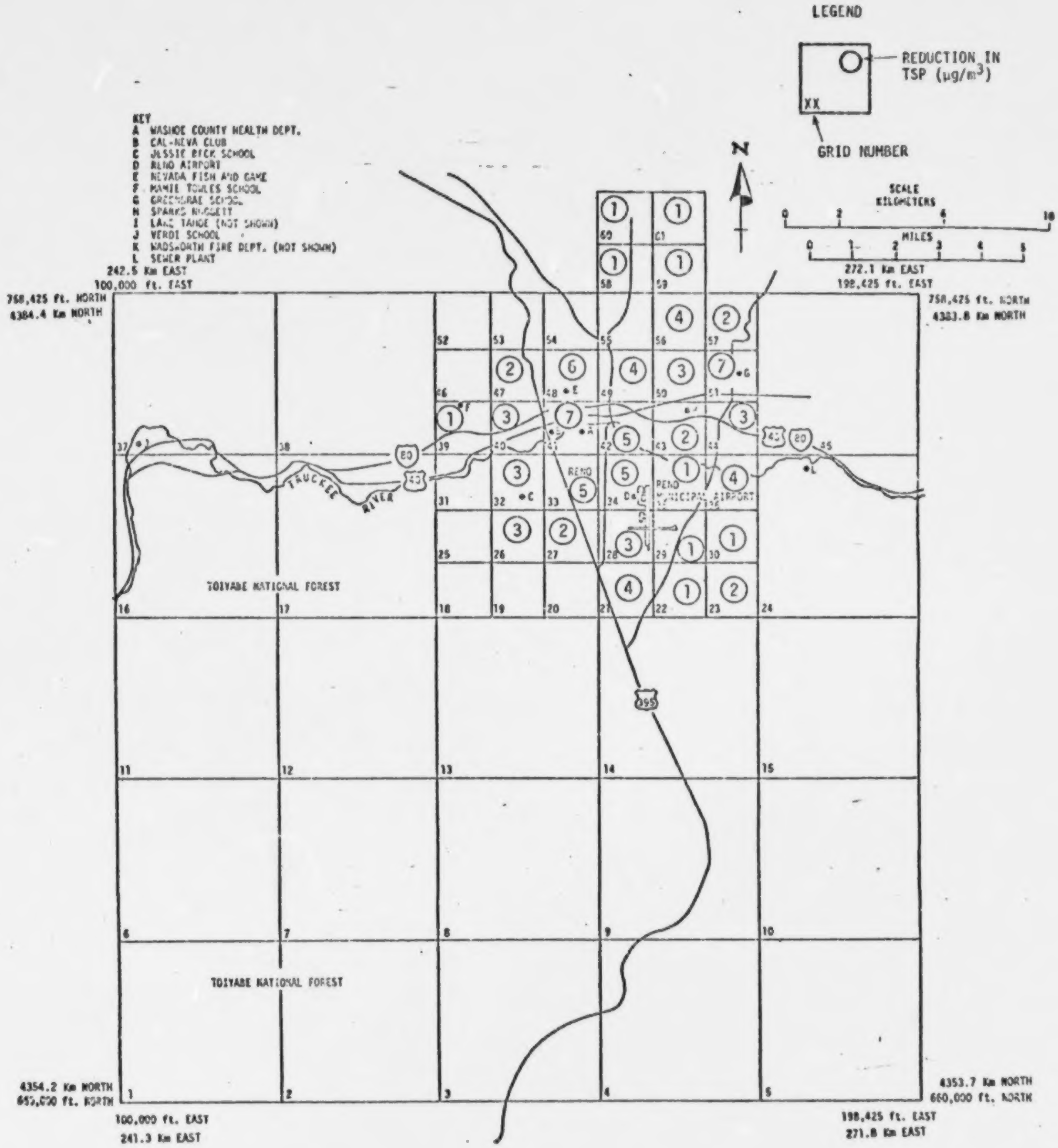

LEGEND
REDUCTION IN TSP (μg/m³)
XX
GRID NUMBER
N
SCALE KILOMETERS
0 2 6 10
MILES
0 1 2 3 4 5
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
242.5 Km EAST.
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
272.1 Km EAST
198,425 ft. EAST
758,425 ft. NORTH
4383.8 Km NORTH
4
1
3
1
2
1
1
80
40
395
TRUCKEE RIVER
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
4364.2 Km NORTH
653,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
650,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST

Figure 7.3 Change in 1985 Reno air quality due to road paving.



LEGEND
REDUCTION IN TSP ($\mu g/m^3$)
XX
GRID NUMBER
N
SCALE
KILOMETERS
0
2
6
10
MILES
0
1
2
3
4
5
272.1 Km EAST
198,425 ft. EAST
KEY
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
242.5 Km EAST
100,000 ft. EAST
758,425 ft. NORTH
4384.4 Km NORTH
758,425 ft. NORTH
4383.8 Km NORTH
① 60
① 61
① 58
① 59
④ 56
② 57
52
53
54
55
② 47
⑥ 48
④ 49
③ 50
⑦ 51
46
① 39
③ 40
⑦ 41
⑤ 42
② 43
③ 44
37
38
45
③ 32
⑤ 33
⑤ 34
① 35
④ 36
31
③ 26
② 27
③ 28
① 29
① 30
25
④ 21
① 22
② 23
16
17
18
19
20
24
80
40
395
TRUCKEE RIVER
RENO
RENO MUNICIPAL AIRPORT
TOIYABE NATIONAL FOREST
11
12
13
14
15
6
7
8
9
10
TOIYABE NATIONAL FOREST
1
2
3
4
5
4354.2 Km NORTH
655,000 ft. NORTH
100,000 ft. EAST
241.3 Km EAST
4353.7 Km NORTH
660,000 ft. NORTH
198,425 ft. EAST
271.8 Km EAST

Figure 7.4 Total change in 1985 Reno air quality due to all control strategies.

8. REGULATORY CONSIDERATIONS

In dealing with TSP non-attainment situations, two sources of fugitive particulate emissions must be considered in conjunction with the relatively well-defined particulate loadings emitted from process stacks and vents. These sources of fugitive particulates can be classified as either "fugitive emissions" or "fugitive dust." Ideally, a fugitive particulate regulation should be applicable to both source categories and control both types of emissions. Fugitive emissions may be generally defined as including those that result from industrial related operations and which escape to the atmosphere through windows, doors, leaks, etc.; not through a primary exhaust system, such as a stack, flue, or control system." For most purposes fugitive dusts are generally related to natural or man-associated particulates that become airborne due to the forces of wind, man's activity, or both.

Presently there are four general regulatory approaches that have been used to control either or both types of fugitive particulates:

- Nuisance Provisions
- Opacity Limitations
- Performance Standards
- Air Quality Measurements, in terms of total suspended particulates.

Nuisance provisions are based upon traditional concepts of "unreasonable interferences with the rights of others", and necessarily depend upon the subjective opinions of a number of citizens as to the harm being caused them by some source.

Opacity limitations relate to the optical properties of emitted particulate matter and assume that there is a meaningful relationship between the light obscuring properties of the particulate matter emitted by a fugitive dust or fugitive emission source and the mass per unit time of particulate matter emitted by such a source. Implied in such a concept is the assumption that there is a similar relationship between opacity and ambient concentrations of particulate matter.

Performance standards are specifications as to the ways certain fugitive particulate sources should be constructed or operated. This concept evolves from the fact that there are no well-established or standard ways to measure the amount of dust being emitted by most fugitive sources, hence no way to establish quantitative emission standards for those sources. As a result, the concept suggests that ways of controlling emissions should be specified rather than allowable amounts of emissions.

Air quality measurements assess the impact of the fugitive particulate source's emissions upon air quality. They can be measured either with dustfall jars for settleable particulates, high volume samplers for suspended particulates, or paper tape samplers for the soiling properties of the emitted dust. Where high volume samplers are used, the source's impact can be directly related to the NAAQS.

Selecting which of these approaches is preferable for incorporation in a regulation is not a simple task. All have drawbacks and merits relative to each other. The end result is that no one approach is clearly preferable.

The remainder of this section is devoted to a discussion of factors/approaches pertinent to specific control options considered in this report.

STREET CLEANING

There are three basic types of street sweepers in use today: mechanical broom, regenerative air, and vacuum. Street flushers also are used in some areas. The broom sweeper moves material from the gutter into the main pickup broom which rotates to carry the material onto a belt and into the hopper. The regenerative air system blasts the dirt and debris from the road surface into the hopper with a portion of the air being recycled. Vacuum sweepers use both a broom for loosening and moving street dirt debris and a vacuum system to pick up the debris. Street flushers use sprayed water to displace dirt and debris from the street surface to the gutter. The volume of water used is normally insufficient to transport the accumulated debris to the nearest drain.

In general, what little literature is available suggests that flushers provide little air pollution control benefit. Broom sweepers will collect in excess of 50 percent of the debris loading, but tend to produce more respirable range particles and spread the debris more uniformly across the road. One operational limitation which makes its use alone in reducing reentrained dust of doubtful value is that it is not efficient in removing fine particles. Regenerative air sweepers tend to remove material at lower efficiencies (approximately 40 percent) and produce the same adverse impacts as do the broom sweepers. Vacuum sweepers seem to collect material at much higher collection efficiencies without the adverse impacts associated with the other two types.

The current street cleaning program in Reno involves 1 vacuum-type and 6 broom-type cleaners operating on a 7-day cycle at an average cost of $1.06 per mile per cycle. This cost includes operation, maintenance and labor. Sparks operates 1 vacuum-type and 2 broom-type cleaners on a 3.5-day cycle. The vacuum-type cleaner costs $1.05 per mile per cycle to operate and maintain, while the broom-type cleaner costs $0.63 per mile per cycle. Assuming each of the Sparks cleaners handles an equal length of street, the broom-type cleaners will clean 144 curb-miles twice per week, while the vacuum-type cleaner will clean 72 curb-miles. In this area the total annual cost of street cleaning is:

Reno

($1.06/curb-mi/cyc)(1400 curb-mi)(50 cyc/yr) = $74,200

Sparks (broom-type)

($0.63/curb-mi/cyc)(144 curb-mi)(100 cyc/yr) = $ 9,072

Sparks (vacuum-type)

($1.05/curb-mi/cyc)(72 curb-mi)(100 cyc/yr) = $ 7,560

Total annual cost = $90,832

For implementation of the proposed control strategy, the capital cost of 8 new vacuum-type cleaners is $360,000, while the operating and maintenance costs for these cleaners is $84,840 annually.

The most feasible way to implement this control strategy would be for the Washoe County DEP to enter into an "Administrative Agreement" with its appropriate counterpart in the County Government. Items of major importance in such an agreement include:

- Specification of the type and number of street cleaning units and ancillary equipment required, along with a schedule for their acquisition.

- Specification of the skill requirements for and number of personnel required, along with a schedule for their hiring.

- Specific designation of the street boundaries to be cleaned, along with a schedule for cleaning operations based on a minimum required frequency.

- The required funding plan, showing how and when these monetary needs will be included as "line items" in proposed Washoe County budget allocations.

- A mechanism for periodic intra-agency review of program status progress in light of air quality measurement evaluations, i.e., attainment and maintenance of NAAQS.

Inherent in any such "Administrative Agreement" should be the flexibility to allow modifications and/or changes to the agreement which may be required as the program progresses. More detail on improving street cleaning through the implementation of such an administrative agreement is given in Appendix A.

9. APPENDIX

APPENDIX A

PROGRAMS FOR IMPROVED STREET CLEANING[1]

THE CONCEPT OF AN ADMINISTRATIVE AGREEMENT

Regulations requiring municipalities to adopt specific street cleaning practices for air pollution control purposes would probably be unsuccessful, principally because present knowledge of controls for reentrained dust is insufficient to define general regulatory terms which outline the optimum street cleaning program for a city. As an alternative to regulation, the use of an administrative agreement between the air pollution control agency and the local government is proposed. Through this agreement, the local government would be committed to institute changes in street cleaning practices in order to improve particulate air quality.

The term "administrative agreement" as used herein refers to a written agreement entered into by two or more governmental units. Such an agreement would constitute a formal, but not necessarily legally enforceable, commitment by one governmental unit to engage in a specific set of activities. It would consist of a statement of local governmental policy regarding street cleaning and air pollution control and a plan by that body to implement programs, including any necessary budgetary adjustments. A timetable for implementing the actions would also be specified in the written agreement. An example of this type of agreement is presented in Figure A-1.

This AGREEMENT made and entered into on this the ________ day of ______, 19__, by and between the STATE of _______, hereinafter referred to as the Party of the First Part, and the CITY OF _______ _______, a municipal corporation organized and existing under and by virtue of the laws of the State of _________, hereinafter referred to as the Party of the Second Part.

WITNESSETH:

That, WHEREAS, the parties hereto recognize that there is a great need on the part of their citizens for a program and/or system for controlling dust from paved streets and parking facilities affecting air quality within the jurisdictions of the party of the first part and the party of the second part; and

WHEREAS, the party of the first part has found that the institution of a program and/or system for controlling air pollution from paved surfaces is necessary in order to achieve the intents and purposes of the State Air Pollution Control Implementation Plan; and

WHEREAS, the party of the second part is desirous and willing to define and implement policies and execute programs which will produce effective control of dust from paved surfaces owned and operated by the party of the second part.

NOW, THEREFORE, in consideration of the premises and in the further consideration of the mutual agreements and covenants hereinafter contained, the parties hereby enter into the following agreements:

1. The party of the second part is authorized by the party of the first part to carry out those portions of the State Air Pollution Control Implementation Plan relating to control of dust from paved streets within its jurisdiction.

2. It is agreed that the party of the first part, acting through its Department of Environmental Protection, will provide technical assistance to the party of the second part in defining the degree and extent of fugitive dust control required on the paved surfaces within the boundaries and jurisdiction of the party of the second part.

3. It is agreed that the party of the second part will within two months of the date of this agreement adopt a resolution stating that it is the policy of the party of the second part to modify street cleaning practices to meet air quality objectives; within six months of the date of this agreement specify and submit to the party of the first part a detailed program for implementing said policy, which program shall include such elements as both parties agree to be necessary; and at the time of the next following budget approval submit to the party of the first part an operating budget and capital expenditures budget which provides the fundings necessary to implement the programs so developed.

4. It is agreed that the party of the first part and the party of the second part will equally share the expense of determining the degree and extent of dust control required, and that the party of the first part will assist the party of the second part in finding supplementary sources of funding to implement the programs developed as a part of this agreement.

IN TESTIMONY WHEREOF, the parties hereto have caused this agreement to be executed, in duplicate, by their duly authorized agents and/or officials, as of the day and year first above written,

ATTEST:	STATE OF____________________
______________________________ Recorder	By____________________________ Executive Director, Department of Environmental Protection
ATTEST:	CITY OF_____________________
______________________________ Clerk	By____________________________ Mayor

Figure A-1. Example administrative agreement.

There has been no indication whether such a nonregulatory approach would be approvable by EPA if submitted as part of an SIP revision. The Federal regulations (40 CFR 51.11f) do allow the state to delegate authority to carry out part of the plan:

> "The State may authorize a local agency to carry out a plan, or portion thereof, within such local agency's jurisdiction: Provided, that such plan demonstrates, to the Administrator's satisfaction, that such local agency has the legal authority necessary to implement such plan, or portion thereof, and further: Provided, that such authorization shall not relieve the State of responsibility under the Act for carrying out such plan, or portion thereof."

The municipalities certainly have legal authority to clean their streets. The uncertainty arises in whether every measure identified in the control strategy must be backed by a regulation. Also, the agency has no basis for seeking injunctive relief for nonperformance by the municipality and has no legal authority for cleaning the streets if the municipality fails to do so.

No precedents for comparable situations to this could be found in other EPA regulatory areas. The agreement shows recognition of the state agency's objectives and an intent to comply with program requirements that are not as yet defined because they must be designed specifically for each municipality.

IMPLEMENTATION OF AN ADMINISTRATIVE AGREEMENT

There are five basic elements to the process of developing the type of administrative agreement discussed herein:

- decision by the air pollution control agency that improved street cleaning is necessary in order to attain and maintain air quality standards;
- establishment of a joint institutional mechanism with the public works department to define the nature of such improvements;
- provision of active technical assistance on the part of the air pollution control agency;
- adoption of altered street cleaning practices as a matter of local governmental policy;
- development of program elements designed to implement and assess those desired improvements.

The first of these is amply discussed in other portions of this report and need not be discussed further here.

Institutional Mechanisms

Modifications to the street cleaning program determined independently by the air pollution control agency have no better chance of being implemented than equivalent regulations adopted by the agency. Rather, what is required is an institutional process for agreeing upon changes that can be fitted into the existing street cleaning operations with the optimum mix of minimized change and maximized air pollution control effectiveness.

It is suggested that a committee comprised of representatives of both organizations be appointed to determine the technical means of achieving the desired degree of improvement in air quality. This committee process might be rather difficult to implement in practice due to differing organizational imperatives.

Technical Assistance

A public works department cannot be expected to know what must be done to reduce the air quality impact of reentrained dust from paved streets. Nor can an air pollution control agency be expected to know what must be done to clean streets efficiently and effectively. Each group must work with the other, as is implied by the administrative agreement concept, to determine what must be done to produce mutally desirable results.

To this end, the air pollution control agency must provide three services: guidelines as to what equipment and procedures are most beneficial in terms of air quality; directions as to what parts of the municipality are most in need of improved air quality; and air quality sampling data which can be used to monitor and assess the effect of modifications in the existing street cleaning system.

Municipal Policy Development

In making policy decisions that add, delete, or modify community objectives, municipal administrations are usually responding to public pressure, special interest groups, perceived need by the administration itself, or consideration of requirements or desires of other governmental entities. The municipal administration must determine the likely costs and benefits of the improvements in air quality that can be expected from altered street cleaning practices and where and how the necessary modifications in activities and expenditures are to be made. Once these questions have been satisfactorily answered the municipal administration can then draft a resolution stating the policy to be followed and submit it to the city council for a vote under its prescribed rules of ratification. Wording of the resolution in each municipality will vary, but may approximate the model shown in Figure A-2. Following favorable adoption of such a resolution, administrative and other legislative actions will be required to implement the policy. The first administrative step involves program planning and development.

BY THE COUNCIL:

WHEREAS, this Council has, through the State Department of Environmental Protection, become aware of overall air quality plan objectives for the State and this municipality; and

WHEREAS, this Council recognizes that national air quality objectives are embodied in the State objectives; and

WHEREAS, this Council also recognizes the need to modify street cleaning practices in order to meet air quality objectives and protect the health and welfare of the citizens of this municipality; and

WHEREAS, this Council has been advised that by reordering public works expenditures and procedures and modifying existing powers and programs that this municipality can achieve a significant measure of air quality improvement through control of reentrained dust;

NOW THEREFORE, BE IT RESOLVED by the Village/City Council of this municipality, that program plans and implementation be directed toward a systematic modification of street cleaning practices;

BE IT FURTHER RESOLVED that the Department of Public Works is directed to cooperate with the State Department of Environmental Protection to define jointly the nature, degree, and extent of those modifications which are necessary to implement this policy; and

BE IT FURTHER RESOLVED that the Clerk of this Council is hereby directed to certify copies of this resolution to Village/City Directors of Public Works, Office of Budget, and Community Planning for program planning and execution.

ADOPTED at a regular meeting of the Village/City Council of Any County, Every State this ____________ day of ___________, 19__.

Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY
Council-Person ______AYE ______NAY

CERTIFICATE OF CLERK

IT IS HEREBY CERTIFIED that the foregoing is a true and correct transcript of a resolution adopted by this Council in session the __________ day of ________, 19__.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the Village/City Council of Any County, Every State this __________ day of __________.

____
Clerk
Village/City Council

Figure A-2. Example city council resolution.

Program Planning and Development

Programs are action-oriented media for carrying out policies. The increasing complexity, number, and technical character of municipal problems makes it necessary that program planning be accomplished in a systematic manner. Moreover, the multiplicity of municipal needs that compete for funds makes it imperative that any new program or major program modification be well-conceived and well-presented.

Programming provides the framework for rational decisions. This framework may be categorized into assessing existing programs, determining where these programs can be most effectively applied, identifying new areas of concern, designing new programs, and scheduling new programs.

Programming options for controlling dust from municipally-owned paved surfaces are largely limited to public works or street cleaning functions and activities. To achieve improved reentrainment dust control may require improved maintenance of existing street cleaning equipment, purchase of new or different equipment, improvement of employee training programs, more frequent street sweeping, and/or modifying the specific sequence of activities in a given area. It may be desirable to program joint agreements with neighboring jurisdictions. In addition, programs related to Areawide Waste Treatment Management Planning (Section 208, P.L. 92-500) requirements may need to be integrated with those related to air quality.

According to the International City Manager's Association (ICMA),[2] there are four basic ingredients to the actual process of developing street cleaning programs:

- adequate planning maps,
- definition of desirable frequency and time of cleaning for individual streets,

- development of routes, and
- scheduling control.

The air pollution control agency should obtain enough of this type of information from the public works department so that the agency can interactively determine with the department what modifications need to be made as a part of the effort to reduce reentrained dust from paved surfaces.

Budgeting Mechanisms

Implementing the changes agreed upon during the process of program development will require modifications in the budget that would otherwise be prepared. Such modifications may include the same budgeting mechanisms as used for other municipal functions: the annual operating budget and the capital improvements budget.

A reordering of existing budget priorities may be necessary. For example, if more frequent cleaning is required in a specific part of the municipality, then either services will be cut back in other parts of town, productivity will increase, funds will be shifted to the public works department from other departments, or an increase in overall financial resources will be obtained. These alternatives clearly imply that a thorough analysis of how the requisite changes can be implemented most efficiently is required. Likewise, additional street cleaning equipment may have to be purchased. The air pollution control agency must make every effort to provide the public works department with the best possible information concerning the air pollution control effectiveness of different types of street cleaning equipment.

Any effort to improve street cleaning practices will have to be conceived with recognition that funding sources for local governments are limited and that the fundable improvements must first be incorporated in the next year's approved budget, which would prevent very rapid implementation.

REFERENCES

1. Control of Reentrained Material from Paved Streets. Prepared by PEDCo Environmental, Inc. for U.S. Environmental Protection Agency, Region VII, March 1976 (Draft).

2. Korbitz, W.E. (Ed.) Urban Public Works Administration. Washington D.C., International City Management Association, 1976.

TASK F REPORT
PARTICULATE CHARACTERIZATION STUDY

1. INTRODUCTION

Following the completion of Tasks A (Evaluation of Air Quality Data) and B (Factors Influencing Fugitive Emissions), the Project Coordinating Group supported a proposal by the EPA Project Officer to expend a specified level of contractual effort in an attempt to evaluate ambient samples relative to their particulate characterization. Both historical samples collected by the agencies and samples collected during the period March-April, 1976, were analyzed by both microscopic and chemical techniques. Insofar as possible, similar samples collected by compatible methods were obtained in approximately the same number for both the Clark-Mohave-Yuma and Northwest Nevada Intrastate AQCR's.

The historical samples were primarily used for analytical technique screening and evaluation purposes. Special samples, concurrently collected by "hi-vol samplers" using regular glass fiber filters and cellulose acetate filters, along with a "hi-vol" equipped for sampling with the Andersen modification for mass fractionation, were obtained at three (3) sites in each AQCR on five (5) successive regular TSP sampling days. Analysis of these data was projected to yield information relative to:

- The development of "weighing factors" for more accurately defining the impact of fugitive dust emissions reduction on projected ambient air quality.

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- Findings and conclusions from evaluation of the "hi-vol" particulate size distribution analyses and the Andersen fractionating data.

- An estimation of the effect of nearby and distant sources on receptors as percent contribution under varying concentration conditions.

Section 2.0 of this report relates the analytical methodology used for the particulate samples. Specifically, these approaches included:

- Microscopic (polarized light) analysis for particle size distribution, origin classes of particles, and percent count and mass of each significant origin class.

- Silica fraction by wet chemical (gravimetric) method.

- Combustible fraction by chemical (gravimetric) method.

- Calcium by the atomic absorption method.

- Lead by the atomic absorption method.

Sections 3.0 and 4.0 present data summaries for each AQCR, using several modes of tabulation. Section 5.0 covers the development of regional "weighing factors" for fugitive emissions impact while a limited amount of data analysis and interpretation is provided in Section 6.0. Relative to this final section, we wish to point out that extreme care should be taken relative to conclusions developed from these analysis as well as possible application of these factors in other areas, due to the limited number of samples plus seasonal constraints placed on the sampling program.

2. APPROACH

SAMPLING NETWORK

The special sampling program was conducted at three of the regular high volume sampler sites in both Las Vegas and Reno. The sites in Las Vegas were the Sahara Hotel, Henderson Post Office, and Sunrise Power Plant. These sites are shown in Figure 2-1. The sites in Reno were the Cal-Neva Club, Sparks Nugget, and Washoe County Health Department. These sites are shown in Figure 2-2.

SAMPLES ANALYZED

Two types of samples were collected: total suspended particulates (TSP) and soil. The TSP samples were collected on three types of filters: 8 in. x 10 in. glass fiber, 8 in. x 10 in. cellulose acetate (millipore), and Andersen Cascade glass fiber. Soil samples were collected within the vicinity (1/4 mile radius) of the sampling stations. Collections on cellulose acetate filters were made so that direct microscopic examination could be performed as well as chemical determination of the silica content of the TSP (glass fiber filters are predominantly silicate). Table 2-1 shows the sampling protocol for the special TSP samples. In addition, historical samples representing the highest and fifth highest particulate concentrations after December 1975 for both Las Vegas and Reno were also submitted for microscopic and chemical analysis. Table 2-2 describes the soil sampling sites.

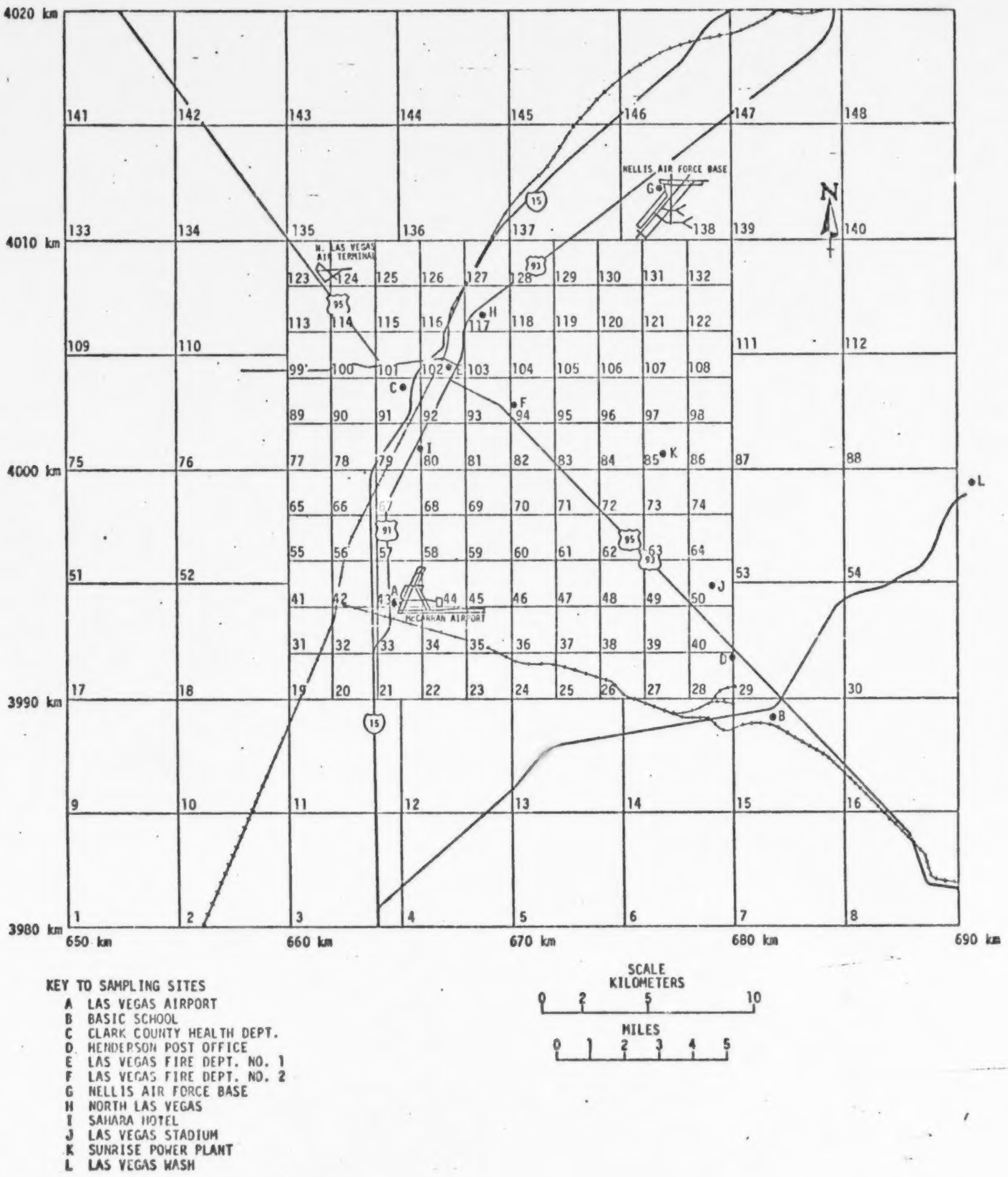
4020 km
4010 km
4000 km
3990 km
3980 km
650 km
660 km
670 km
680 km
690 km
N
NELLIS AIR FORCE BASE
N. LAS VEGAS AIR TERMINAL
McCARRAN AIRPORT
15
93
95
91
KEY TO SAMPLING SITES
A LAS VEGAS AIRPORT
B BASIC SCHOOL
C CLARK COUNTY HEALTH DEPT.
D HENDERSON POST OFFICE
E LAS VEGAS FIRE DEPT. NO. 1
F LAS VEGAS FIRE DEPT. NO. 2
G NELLIS AIR FORCE BASE
H NORTH LAS VEGAS
I SAHARA HOTEL
J LAS VEGAS STADIUM
K SUNRISE POWER PLANT
L LAS VEGAS WASH
SCALE
KILOMETERS
0 2 5 10
MILES
0 1 2 3 4 5

Figure 2-1. Las Vegas high volume sampler network with study area grid overlay.

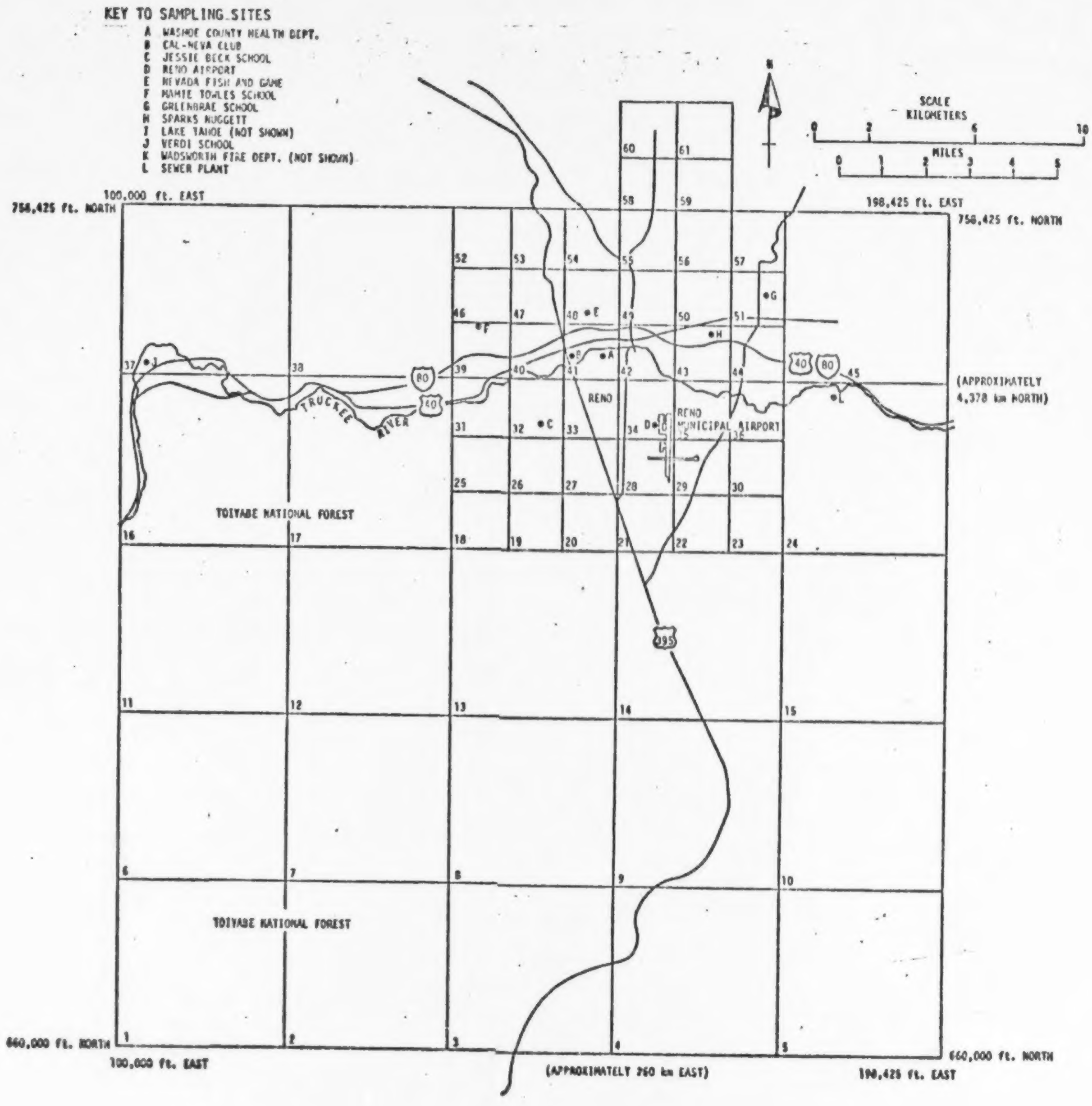
KEY TO SAMPLING SITES
A WASHOE COUNTY HEALTH DEPT.
B CAL-NEVA CLUB
C JESSIE BECK SCHOOL
D RENO AIRPORT
E NEVADA FISH AND GAME
F MAMIE TOWLES SCHOOL
G GREENBRAE SCHOOL
H SPARKS NUGGETT
I LAKE TAHOE (NOT SHOWN)
J VERDI SCHOOL
K WADSWORTH FIRE DEPT. (NOT SHOWN)
L SEWER PLANT
N
SCALE
KILOMETERS
0
2
6
10
MILES
0
1
2
3
4
5
100,000 ft. EAST
758,425 ft. NORTH
198,425 ft. EAST
758,425 ft. NORTH
(APPROXIMATELY 4,378 km NORTH)
TRUCKEE RIVER
RENO
RENO MUNICIPAL AIRPORT
80
40
395
TOIYABE NATIONAL FOREST
TOIYABE NATIONAL FOREST
660,000 ft. NORTH
100,000 ft. EAST
(APPROXIMATELY 260 km EAST)
198,425 ft. EAST
660,000 ft. NORTH

Figure 2-2. Reno high volume sampler network with study area grid overlay.

Table 2-1. SAMPLING PROTOCOL

Date	Las Vegas sampling sites		
	Sahara Hotel	Henderson Post Office	Sunrise Power Plant
3/31/76	1,2,3	1,2	1,2,3
4/6/76	1,2,3	1,2	
4/12/76	1,2,3	1,2	1,2,3
4/18/76	1,2,3	1,2	1,2,3
4/24/76	3		3

Date	Reno sampling sites		
	Cal-Neva Club	Sparks Nugget	Washoe County Health Dept.
4/6/76	1,2	1,2,3	2
4/12/76	1,2	1,2	1,2
4/18/76	1,2	1,2,3	2
4/24/76	1,2	1,2,3	1,2
4/30/76	1,2	1,2,3	2

Key to sampling filters
1 = Glass Fiber Hi-Vol
2 = Cellulose Acetate (Millipore) Hi-Vol
3 = Andersen Cascade Series

Table 2-2. SOIL SAMPLING SITES

City	Sample No.	Date	Site
Las Vegas	1	5/10/76	400 feet west of Sunrise Power Plant Hi Vol
Las Vegas	2	5/10/76	600 feet east of Sunrise Power Plant Hi Vol
Las Vegas	3	5/10/76	600 feet south of Sunrise Power Plant Hi Vol
Las Vegas	4	5/10/76	1/2 mile north of Sunrise Power Plant Hi Vol
Las Vegas	5	5/10/76	500 feet west of Henderson Post Office Hi Vol
Las Vegas	6	5/10/76	500 feet south of Henderson Post Office Hi Vol
Las Vegas	7	5/10/76	200 feet east of Henderson Post Office Hi Vol, from highway gutter
Las Vegas	8	5/10/76	1/4 mile north of Henderson Post Office Hi Vol
Las Vegas	9	5/10/76	400 feet south of Sahara Hotel Hi Vol
Las Vegas	10	5/10/76	1000 feet west-southwest of Sahara Hotel Hi Vol
Las Vegas	11	5/10/76	1000 feet east of Sahara Hotel Hi Vol
Las Vegas	12	5/10/76	1/4 mile north of Sahara Hotel Hi Vol
Reno	1	4/20/76	200 yards south of I-80 at Kleepe Lane
Reno	2	4/20/76	E. Glendale Rd. at Merideth Way

Table 2-2 (continued). SOIL SAMPLING SITES

City	Sample No.	Date	Site
Reno	3	4/20/76	N.E. corner of E. Glendale Rd. at Bergin Way
Reno	4	4/20/76	E. Glendale Rd. at Industrial Way
Reno	5	4/20/76	E. Glendale Rd. at Galletti Way
Reno	6	4/20/76	Kuenzli Ln. at Manuel
Reno	7	4/20/76	Lake St. and Plaza
Reno	8	4/20/76	W. 2nd St. and Arletta Way
Reno	9	4/20/76	1/2 mile west of city limit on Rt. 40
Reno	10	4/20/76	Twin Lakes Dr., 0.4 mile north of Rt. 40
Reno	11	4/20/76	Rt. 395 and Parr Blvd.
Reno	12	4/20/76	Rt. 395 and Oddie Blvd.
Reno	13	4/20/76	Colonly Rd. at E. 2nd St.
Reno	14	4/20/76	(Sample vial not numbered)
Reno	15	4/21/76	South-west corner Kietzke at Moana Ln.
Reno	16	4/21/76	South-west corner S. Virginia at Hash Ln.
Reno	17	4/21/76	South-west corner Rock Blvd. at Boynton Ln.
Reno	18	4/21/76	Pyramid Rd. at Queen Way
Reno	19	4/21/76	(Sample vial not numbered)
Reno	20	4/21/76	Plumb Ln. at Ferris Ln.

METHODS OF ANALYSIS

The particulates collected on 8 in. x 10 in. glass fiber and membrane filters were subjected to both microscopic and chemical analysis. Microscopic analysis included the differentiation of particulate classes as well as particle sizing within each class. Chemical analysis included the measurement of lead, calcium, combustibles, and silicates. Table 2-3 depicts the analytical protocol.

Microscopic Analysis

The glass fiber filters were heavily loaded and embedded with particulates so that direct microscopic analysis could not be done. The technique used was to resuspend a randomly selected core (11 mm diameter) in 10 to 15 ml distilled water with the use of an ultrasonic bath and a drop of wetting agent and refiltering onto a 47 mm membrane filter (effective filtering diameter, 35 mm). Four cores were randomly selected from each 8 in. x 10 in. glass fiber filter. An angular wedge of approximately 30° from each of these membrane filters was sampled by cutting along the radii beginning at the center of the filter.

However, the cellulose acetate (membrane) hi-vol filters were not as heavily loaded as the glass fiber filters, making possible direct microscopic analysis. A clearing solution was prepared consisting of equal volumes of dimethyl pthalate and diethyl oxalate and thickened with a 0.5 g of clean membrane filter material for each 10 ml of solution. A drop of this clearing solution was placed on a glass microscope slide and distributed into an angular wedge with the use of a clean glass rod. The membrane or cellulose acetate filter wedge was placed into this pool of solvent and dissolved in approximately one minute. A cover

Table 2-3. ANALYTICAL PROTOCOL

Sample	Analysis
Glass fiber filter	A,C,D
Membrane (millipore) filter	A,B,C,D
Soil	B,C,D
Andersen Cascade	E

Key to type of analysis
A = Microscopic Analysis
B = Silica Analysis
C = Combustible Matter Analysis
D = Metal Analysis (Calcium and lead)
E = Gravimetric Analysis for Particle Size Distribution

[illegible]

glass was placed over the cleared sample. After a suitable waiting period to allow entrapped air bubbles to migrate out from under the cover glass (30 minutes), the slide was read under a microscope equipped with a polarizer and a calibrated Porton reticle. The particles within the measurement area of the reticle (counting field) were classified and particle sized. Minerals were counted under polarized light but differentiation of minerals was not possible. Five fields were counted for each wedge at a magnification of 100X.

Three classes of materials were observed. These were combustion products, minerals, and tire tread abrasions. Combustion products are those particles black in appearance and carbonaceous in origin. They are generally spherical in shape; however, rectangular shapes typical of wood origin were also observed. Mineral particles are defined as those which have the ability to polarize light. In a completely crossed polar field, minimal light is observed. However, mineral products uncross the polars thereby passing light at that particular point. The resultant image can be best described as looking at the night sky. The stars would be analogous to the minerals. Tire treads are defined as those particles which are black elongated (cigar shape) particles, slightly curled and rough in appearance. Their origin stems from the abrasive scuffing action of the tire against the road bed.

Calculation of percent distribution by particle size as a function of numbers and weight was determined. Percent by number was a straight fractional percent of the total particles for all classes of material. Percent by weight was determined by multiplying the number of particles by the volume of the particle and the density of each particular material class. For particles in the combustion and mineral classes, it was assumed that these particles were spherical in shape and the mean particle diameter was the average of the upper and lower size interval. The density of combustion products was assumed to be 1.0 and the minerals, 2.6. Since the tire abrasions were observed to be cigar-shaped, the volume was assumed to be cylindrical with a length to width ratio of 4. The density of tire tread was determined to be 1.1.[1]

Chemical Analysis

In order to analyze the soils, samples were air dried to equilibrate them with atmospheric moisture. Clumps were broken up and the soils sieved with a U.S. No. 60 screen. Organic matter (e.g., sticks) were ground as small as possible. Only the minus 60 mesh portion of each soil was analyzed. The analytical procedures used during this study for soils and TSP filters are described as follows.

Metals - Strips 1 inch wide were cut from glass and membrane filters. Approximately 1 g of each soil was weighed out. Each sample was refluxed in 25 ml of 5.3 N nitric acid for 3 hours, then filtered and the volume brought to 100 ml. These solutions were analyzed by atomic absorption spectrophotometry for Ca and Pb.

Combustible Matter - One inch strips of filters and approximately 1 g samples of the soils were placed in weighed porcelain crucibles and heated to 500°C in a muffle furnace. After 1 1/2 hours at that temperature, the crucibles were reweighed and the loss determined.

Silica - Two inch wide strips of millipore filters were folded and placed in platinum crucibles, wetted with acetone, and ignited. After the flames subsided, the crucible was brought to red heat with a bunsen burner, cooled, and weighed. Hydrofluoric acid was added and the crucible heated on a hot plate to dryness. Addition of acid was continued until the reaction was complete, indicated by white residue. The crucible was again heated to redness in the gas flame, cooled, and reweighed. The weight difference is the amount of Si in the sample, expressed as SiO_2. A sample of each soil of about 0.1 g was treated similarly except the acetone burning was eliminated.

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[1] Rubber Handbook, G.G. Winspear, Ed. R.T. Vanderbilt Co., Inc. New York. 1968. p. 460-470.

Problem Areas

There were three major problem areas encountered in this study; loading of the glass fiber filter, the inability to determine the particulate loading on the cellulose acetate filter because of its hydroscopic nature, and reliability of the combustible matter and silica determination for the cellulose acetate filters.

The current Hi-Vol glass fiber filter is not compatible for microscopic analysis for several reasons. The surface area is so textured that particles collected in the depressions are so matted that they are not distinguishable under the microscope. Therefore the technique of resuspending the particulates captured on the glass fiber filter and filtering them onto a membrane filter was used. However, the possibility of dissolving some of the particulate, especially mineral material, is not to be precluded. In addition, not all the particulates are freed from the glass fiber filter in cleaning. Extremely small particles are entrapped in the filter and are not released.

The cellulose acetate filters, being organic in nature, are prone to moisture gain and loss to or from the surrounding environment. Although the filters were equilibrated in a constant humidity and temperature room before taring, most loaded filters when returned and equilibrated showed a loss in weight. A possible explanation could be that since the filters were very recently manufactured, they were not completely dried or cured when tared. Then when exposed to the dry humidity of the Reno and Las Vegas areas, the excess moisture may have been lost to the atmosphere.

In the determination of combustible matter on the membrane filter, the filter material, being organic, is totally combusted which necessitates a large blank correction. In all cases the corrected net weight was less than 23 milligrams (about 10% of the correction) and in some cases was less than zero. The problem is more acute in the silica determination where weight losses were less than 9 milligrams and in some cases less than one milligram.

A non-analytical problem which was encountered was the non-reporting for air volumes for five millipore samples at Reno. While the microscopic analysis could be performed, the calculations of chemical concentration, $\mu g/m^3$, could not be determined and these chemical data are not reported.

3. SUMMARY OF DATA FOR LAS VEGAS

Tables 3-1 through 3-15 presents the percent size distribution by both number and weight for the three classes of particulate matter as determined from the glass fiber and millipore hi-vol filters. The summaries are given for each individual sampling station for the entire sampling period and across all sampling stations for each sampling date. When analyzing the data, the particle size distributions from the glass fiber and the millipore filters can not be expected to be the same since the air flow through the millipore is one-half the flow through the glass fiber filters. The difference in air flow rates will affect the size distribution of dust collected on the filters.

Table 3-16 presents the chemical results for the soil samples. Figures 3-1 through 3-8 shows the particle size distributions as determined by the Andersen Cascade Impactors.

Table 3-1. LAS VEGAS GLASS FIBER FILTERS AT HENDERSON POST OFFICE

Station: Henderson

Dates of Collection: March 31, April 6, 12, 18, 1976

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	61	19	0.00	1.8	1.4	0.00
3.7- 5.3	10	2.2	0.00	4.3	2.4	0.00
5.3- 7.4	3.9	1.0	0.00	4.6	3.0	0.00
7.4-10.5	1.4	0.44	0.05	4.6	3.8	0.02
10.5-14.9	0.45	0.22	0.13	4.2	5.2	0.13
14.9-21.0	0.10	0.14	0.12	2.6	9.4	0.31
21.0-29.7	0.03	0.04	0.06	2.0	7.5	0.42
29.7-42.0	0.02	0.01	0.04	3.5	3.0	0.72
42.0-59.4	0.00	0.03	0.02	0.00	34	1.0
>59.4	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	77	23	0.43	28	70	3.0
Total	100			101		

Chemical Analysis

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	1.74	<0.01	4.69
Lead	0.86	0.07	1.94
Combustibles	1.9	1.0	3.4
Silicates*			
TSP**	115	90	149

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-2. LAS VEGAS GLASS FIBER FILTERS AT SAHARA HOTEL

Station: Sahara

Dates of Collection: March 31, April 6, 12, 18, 1976

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	63	18	0.00	1.0	0.73	0.00
3.7- 5.3	7.8	2.9	0.00	1.7	1.7	0.00
5.3- 7.4	2.8	1.1	0.00	1.8	1.8	0.00
7.4-10.5	1.3	0.46	0.02	2.4	2.1	0.00
10.5-14.9	0.66	0.30	0.09	3.3	4.0	0.04
14.9-21.0	0.41	0.15	0.05	5.9	5.6	0.07
21.0-29.7	0.16	0.07	0.04	6.3	6.9	0.15
29.7-42.0	0.10	0.04	0.01	12	11	0.14
42.0-59.4	0.04	0.02	0.00	13	17	0.00
>59.4	0.00	0.00	0.01	1.3	0.00	0.27
Subtotal	76	23	0.22	49	51	0.67
Total	99			101		

Chemical Analysis

Constituent	Concentration, $\mu g/m^3$		
	Average	Low	High
Calcium	3.20	1.17	6.98
Lead	0.76	0.20	1.34
Combustibles	3.1	1.7	5.1
Silicates*			
TSP**	96.3	51	120

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-3. LAS VEGAS GLASS FIBER FILTERS AT SUNRISE POWER PLANT

Station: Sunrise

Dates of Collection: March 31, April 12, 18, 1976

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	64	17	0.00	1.3	0.88	0.00
3.7- 5.3	7.8	3.6	0.00	2.3	2.7	0.00
5.3- 7.4	2.6	1.9	0.00	2.1	4.1	0.00
7.4-10.5	1.1	1.0	0.01	2.6	6.3	0.00
10.5-14.9	0.25	0.68	0.05	1.6	11	0.03
14.9-21.0	0.13	0.15	0.07	2.4	7.2	0.12
21.0-29.7	0.08	0.10	0.06	3.7	13	0.31
29.7-42.0	0.01	0.04	0.03	1.1	14	0.33
42.0-59.4	0.02	0.01	0.04	6.0	7.8	1.5
>59.4	0.00	0.01	0.01	0.00	7.8	0.31
Subtotal	76	24	0.27	23	75	2.6
Total	100			101		

Chemical Analysis

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	3.38	<0.01	8.20
Lead	0.18	0.14	0.21
Combustibles	1.9	0.7	3.9
Silicates*			
TSP**	65	53	82

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-4. LAS VEGAS MILLIPORE FILTERS AT HENDERSON POST OFFICE

Station: Henderson

Dates of Collection: March 31, April 6, 12, 18, 1976

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	67	14	0.00	1.0	0.56	0.00
3.7- 5.3	6.3	2.7	0.00	1.3	1.5	0.00
5.3- 7.4	2.7	1.5	0.00	1.6	2.4	0.00
7.4-10.5	1.6	0.82	0.19	2.7	3.6	0.03
10.5-14.9	0.81	0.41	0.15	3.9	5.2	0.08
14.9-21.0	0.41	0.25	0.09	5.5	8.9	0.12
21.0-29.7	0.21	0.11	0.06	8.2	11	.22
29.7-42.0	0.07	0.04	0.03	7.9	12	.34
42.0-59.4	0.02	0.02	0.01	5.4	14	.32
>59.4	0.00	0.00	0.00	0.00	2.3	0.05
Subtotal	79	20	0.53	38	61	1.2
Total	100			100		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	2.41	1.30	3.01
Lead	1.09	0.11	3.22
Combustibles	15	6.1	20
Silicates*	2.6	2.0	3.6
TSP**			

* Not applicable to Glassfiber Filters
** Not applicable to Millore Filters

Table 3-5. LAS VEGAS MILLIPORE FILTERS AT SAHARA HOTEL

Station: Sahara

Dates of Collection: March 31, April 6, 12, 18, 1976

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	69	15	0.00	1.1	0,59	0.00
3.7- 5.3	5.6	2.4	0.00	1.2	1.4	0.00
5.3- 7.4	2.4	1.1	0.00	1.5	1.8	0.00
7.4-10.5	1.4	0.54	0.16	2.5	2.5	0.03
10.5-14.9	0.97	0.31	0.11	4.8	4.0	0.06
14.9-21.0	0.58	0.15	0.07	8.2	5.5	0.10
21.0-29.7	0.28	0.09	0.06	11	8.9	0.23
29.7-42.0	0.14	0.04	0.02	15	10	0.19
42.0-59.4	0.03	0.00	0.01	10	6.3	0.47
>59.4	0.00	0.00	0.00	0.69	0.90	0.11
Subtotal	80	20	0.43	56	42	1.2
Total	100			99		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	3.55	2.86	4.30
Lead	1.1	.22	1.79
Combustibles	5.6	<1	11
Silicates*	2.6	0.8	4.3
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

Table 3-6. LAS VEGAS MILLIPORE FILTERS AT SUNRISE POWER PLANT

Station: Sunrise

Dates of Collection: March 31, April 12, 18, 1976

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	66	15	0.00	1.4	0.82	0.00
3.7- 5.3	6.0	3.0	0.00	1.8	2.3	0.00
5.3- 7.4	2.4	2.0	0.00	2.0	4.3	0.00
7.4-10.5	1.3	1.3	0.20	3.0	7.7	0.05
10.5-14.9	0.72	0.59	0.16	4.8	10	0.11
14.9-21.0	0.30	0.25	0.07	5.6	12	0.14
21.0-29.7	0.08	0.09	0.05	4.3	13	0.26
29.7-42.0	0.03	0.03	0.00	4.1	12	0.07
42.0-59.4	0.00	0.00	0.00	1.3	6.6	0.07
>59.4	0.00	0.00	0.00	0.00	1.7	0.00
Subtotal	77	22	0.48	29	70	0.70
Total	99			100		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	7.67	1.76	5.02
Lead	0.19	0.11	0.23
Combustibles	9.0	<1	16
Silicates*	2.6	1.9	3.9
TSP**			

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-7. LAS VEGAS GLASS FIBER FILTERS ON MARCH 31, 1976

Date: March 31, 1976

Collecting Stations: Henderson, Sahara, Sunrise

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	61	18	0.00	1.3	1.0	0.00
3.7- 5.3	8.3	3.8	0.00	2.5	3.0	0.00
5.3- 7.4	3.1	2.1	0.00	2.6	4.7	0.00
7.4-10.5	1.1	1.2	0.03	2.7	7.4	0.01
10.5-14.9	0.21	0.60	0.11	1.5	11	0.07
14.9-21.0	0.14	0.18	0.06	2.7	9.3	0.11
21.0-29.7	0.09	0.06	0.04	5.0	9.1	0.24
29.7-42.0	0.01	0.05	0.01	1.1	20	0.11
42.0-59.4	0.01	0.01	0.01	6.2	8.1	0.64
>59.4	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	74	26	0.26	26	74	1.2
Total	100			101		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	5.10	2.42	8.20
Lead	0.87	0.20	1.94
Combustibles	1.6	1.1	1.9
Silicates*			
TSP**	77	51	99

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

Table 3-8. LAS VEGAS GLASS FIBER FILTERS ON APRIL 6, 1976

Date: April 6, 1976

Collecting Stations: Henderson, Sahara

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	71	15	0.00	2.0	1.1	0.00
3.7- 5.3	6.7	1.6	0.00	2.7	1.7	0.00
5.3- 7.4	2.4	0.70	0.00	2.7	2.0	0.00
7.4-10.5	1.2	0.35	0.01	3.8	2.9	0.00
10.5-14.9	0.51	0.18	0.14	4.6	4.3	0.13
14.9-21.0	0.18	0.07	0.11	4.7	4.6	0.28
21.0-29.7	0.05	0.04	0.05	3.9	7.2	0.40
29.7-42.0	0.07	0.00	0.01	14	0.00	0.16
42.0-59.4	0.02	0.02	0.01	13	23	0.46
>59.4	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	82	18	0.33	51	47	1.4
Total	100			99		

Chemical Analysis

Constituent	Concentration, μg/m³		
	Average	Low	High
Calcium	1.06	0.96	1.17
Lead	0.95	0.88	1.03
Combustibles	4.2	3.4	5.1
Silicates*			
TSP**	132	115	149

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-9. LAS VEGAS GLASS FIBER FILTERS ON APRIL 12, 1976

Date: April 12, 1976

Collecting Stations: Henderson, Sahara, Sunrise

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	64	17	0.00	0.94	0.66	0.00
3.7- 5.3	8.3	2.7	0.00	1.7	1.5	0.00
5.3- 7.4	3.0	1.0	0.00	1.8	1.6	0.00
7.4-10.5	1.2	0.41	0.03	2.0	1.8	0.00
10.5-14.9	0.57	0.33	0.05	2.7	4.1	0.02
14.9-21.0	0.39	0.17	0.07	5.2	6.0	0.09
21.0-29.7	0.15	0.08	0.06	5.6	7.9	0.24
29.7-42.0	0.09	0.04	0.02	9.2	11	0.19
42.0-59.4	0.03	0.03	0.03	10	23	0.89
>59.4	0.01	0.00	0.01	1.7	0.00	0.18
Subtotal	78	22	0.27	41	58	1.6
Total	100			101		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	1.83	1.32	2.21
Lead	0.14	0.07	0.20
Combustibles	1.6	0.7	2.8
Silicates*			
TSP**	89	61	108

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-10. LAS VEGAS GLASS FIBER FILTERS ON APRIL 18, 1976

Date: April 18, 1976

Collecting Stations: Henderson, Sahara, Sunrise

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	64	17	0.00	2.0	1.3	0.00
3.7- 5.3	8.9	2.6	0.00	3.8	2.8	0.00
5.3- 7.4	3.2	1.1	0.00	3.9	3.3	0.00
7.4-10.5	1.3	0.35	0.04	4.6	3.2	0.01
10.5-14.9	0.53	0.26	0.07	5.1	6.7	0.07
14.9-21.0	0.16	0.12	0.05	4.4	8.3	0.15
21.0-29.7	0.04	0.05	0.02	3.5	10	0.16
29.7-42.0	0.03	0.01	0.05	5.7	3.7	1.0
42.0-59.4	0.01	0.01	0.01	4.0	21	0.83
>59.4	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	78	22	0.24	37	60	2.2
Total	100			99		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	2.33	<0.01	6.98
Lead	0.70	0.21	1.34
Combustibles	2.5	1.0	3.9
Silicates*			
TSP**	88	53	120

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

Table 3-11. LAS VEGAS MILLIPORE FILTERS ON MARCH 31,1976

Date: March 31, 1976

Collecting Stations: Henderson, Sahara, Sunrise

Filter Type: Millipore

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	72	13	0.00	1.9	0.91	0.00
3.7- 5.3	5.6	2.2	0.00	2.2	2.2	0.00
5.3- 7.4	2.3	1.2	0.00	2.5	3.4	0.00
7.4-10.5	1.2	0.63	0.19	3.8	5.0	0.06
10.5-14.9	0.76	0.29	0.13	6.7	6.6	0.12
14.9-21.0	0.39	0.13	0.07	9.6	8.4	0.19
21.0-29.7	0.13	0.04	0.05	9.1	7.6	0.33
29.7-42.0	0.06	0.01	0.01	12	4.5	0.30
42.0-59.4	0.01	0.00	0.00	8.1	2.1	0.25
>59.4	0.00	0.00	0.00	0.00	2.1	0.00
Subtotal	82	18	0.45	56	43	1.2
Total	100			100		

Chemical Analysis

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	3.66	2.88	5.02
Lead	0.65	0.23	1.23
Combustibles	10	<1	16
Silicates*	2.2	20	2.4
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

Table 3-12. LAS VEGAS MILLIPORE FILTERS ON APRIL 6, 1976

Date: April 6, 1976

Collecting Stations: Henderson, Sahara

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	70	13	0.00	0.81	0.39	0.00
3.7- 5.3	5.7	2.2	0.00	0.93	0.96	0.00
5.3- 7.4	2.6	1.2	0.00	1.2	1.4	0.00
7.4-10.5	1.7	0.62	0.14	2.2	2.1	0.02
10.5-14.9	1.0	0.34	0.14	3.7	3.3	0.05
14.9-21.0	0.57	0.22	0.08	6.1	6.0	0.08
21.0-29.7	0.39	0.12	0.05	12	9.6	0.17
29.7-42.0	0.18	0.06	0.02	15	14	0.18
42.0-59.4	0.02	0.02	0.02	5.9	9.2	0.37
>59.4	0.00	0.00	0.00	1.2	3.1	0.12
Subtotal	82	18	0.45	49	50	0.99
Total	100			100		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	3.65	3.01	4.30
Lead	2.50	1.79	3.22
Combustibles	6.5	6.1	7.0
Silicates*	2.8	2.5	3.2
TSP**			

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-13. LAS VEGAS MILLIPORE FILTERS ON APRIL 12, 1976

Date: April 12, 1976

Collecting Stations: Henderson, Sahara, Sunrise

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	64	14	0.00	1.4	0.79	0.00
3.7- 5.3	7.4	3.3	0.00	2.3	2.7	0.00
5.3- 7.4	3.1	1.9	0.01	2.7	4.2	0.00
7.4-10.5	1.8	1.1	0.24	4.4	6.9	0.06
10.5-14.9	0.99	0.52	0.17	6.9	3.6	0.12
14.9-21.0	0.43	0.26	0.09	8.4	5.1	0.19
21.0-29.7	0.20	0.12	0.06	11	6.8	0.33
29.7-42.0	0.07	0.06	0.01	11	8.5	0.17
42.0-59.4	0.00	0.02	0.00	3.7	8.4	0.10
>59.4	0.00	0.00	0.00	0.00	0.00	0.10
Subtotal	78	21	0.56	52	47	1.1
Total	100			100		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	2.66	2.43	2.86
Lead	0.15	0.11	0.22
Combustibles	8.1	<1	20
Silicates*	2.7	1.9	4.3
TSP**			

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 3-14. LAS VEGAS MILLIPORE FILTERS APRIL 18, 1976

Date: April 18, 1976

Collecting Stations: Henderson, Sahara, Sunrise

Filter Type: Millipore

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	65	18	0.00	1.1	0.76	0.00
3.7- 5.3	5.4	2.9	0.00	1.2	1.8	0.00
5.3- 7.4	2.2	1.7	0.00	1.4	2.9	0.00
7.4-10.5	1.2	1.0	0.15	2.2	4.8	0.03
10.5-14.9	0.75	0.53	0.12	3.9	7.1	0.06
14.9-21.0	0.43	0.25	0.07	6.4	9.7	0.10
21.0-29.7	0.16	0.11	0.06	6.7	12	0.24
29.7-42.0	0.06	0.03	0.02	7.3	10	0.26
42.0-59.4	0.03	0.01	0.02	9.4	8.6	0.53
>59.4	0.00	0.00	0.00	0.00	1.2	0.05
Subtotal	75	25	0.44	40	59	1.3
Total	100			100		

Chemical Analysis

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	2.34	1.30	3.95
Lead	0.65	0.23	1.16
Combustibles	14	11	19
Silicates*	2.8	0.8	3.9
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

Table 3-15. LAS VEGAS HISTORICAL GLASS FIBER FILTERS

Station: Historicals

Dates of Collection: December 20, 25, 26, 1975

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	38	32	0.00	0.63	1.4	0.00
3.7- 5.3	8.3	8.4	0.00	2.0	5.2	0.00
5.3- 7.4	3.4	4.0	0.00	2.3	7.0	<0.01
7.4-10.5	1.5	1.8	0.01	2.8	9.0	<0.01
10.5-14.9	0.49	0.79	0.02	2.6	11	0.01
14.9-21.0	0.17	0.27	0.03	2.6	11	0.05
21.0-29.7	0.08	0.14	0.06	3.2	16	0.27
29.7-42.0	0.02	0.04	0.03	2.5	12	0.36
42.0-59.4	0.00	0.01	0.01	0.99	7.8	0.00
>59.4	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	52	47	0.16	20	80	0.69
Total	99			101		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	24.8	4.77	44.7
Lead	3.58	2.39	4.77
Combustibles	7.98	3.8	10.9
Silicates*			
TSP**	255	162	367

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

Table 3-16. SUMMARY OF LAS VEGAS SOIL ANALYSES

Sample	Site	Ca mg/g	Pb mg/g	SiO_2 mg/g	Combust. mg/g
1	400 feet west of Sunrise Power Plant Hi Vol	64.6	0.02	241	48.3
2	600 feet east of Sunrise Power Plant Hi Vol	79.7	0.06	240	73.9
3	600 feet south of Sunrise Power Plant Hi Vol	69.5	0.11	243	20.6
4	1/2 mile north of Sunrise Power Plant	79.7	0.01	237	15.0
5	500 feet west of Henderson Post Office Hi Vol	36.5	0.261	542	32.6
6	500 feet south of Henderson Post Office Hi Vol	27.9	0.14	468	76.4
7	200 feet east of Henderson Post Office Hi Vol, from highway gutter	28.0	2.50	665	33.6
8	1/4 mile north of Henderson Post Office Hi Vol	33.0	0.10	587	60.6
9	400 feet south of Sahara Hotel Hi Vol	85.0	0.10	185	47.4
10	1000 feet west-southwest of Sahara Hotel Hi Vol	55.3	1.02	256	28.6
11	1000 feet east of Sahara Hotel Hi Vol	94.7	0.15	238	48.4
12	1/4 mile north of Sahara Hotel Hi Vol	67.7	0.10	294	60.5

Figure 3-1. Andersen Cascade Size Distribution for Las Vegas Site Sunrise Power Plant, sampling period 3/31/76 (48 hrs.).

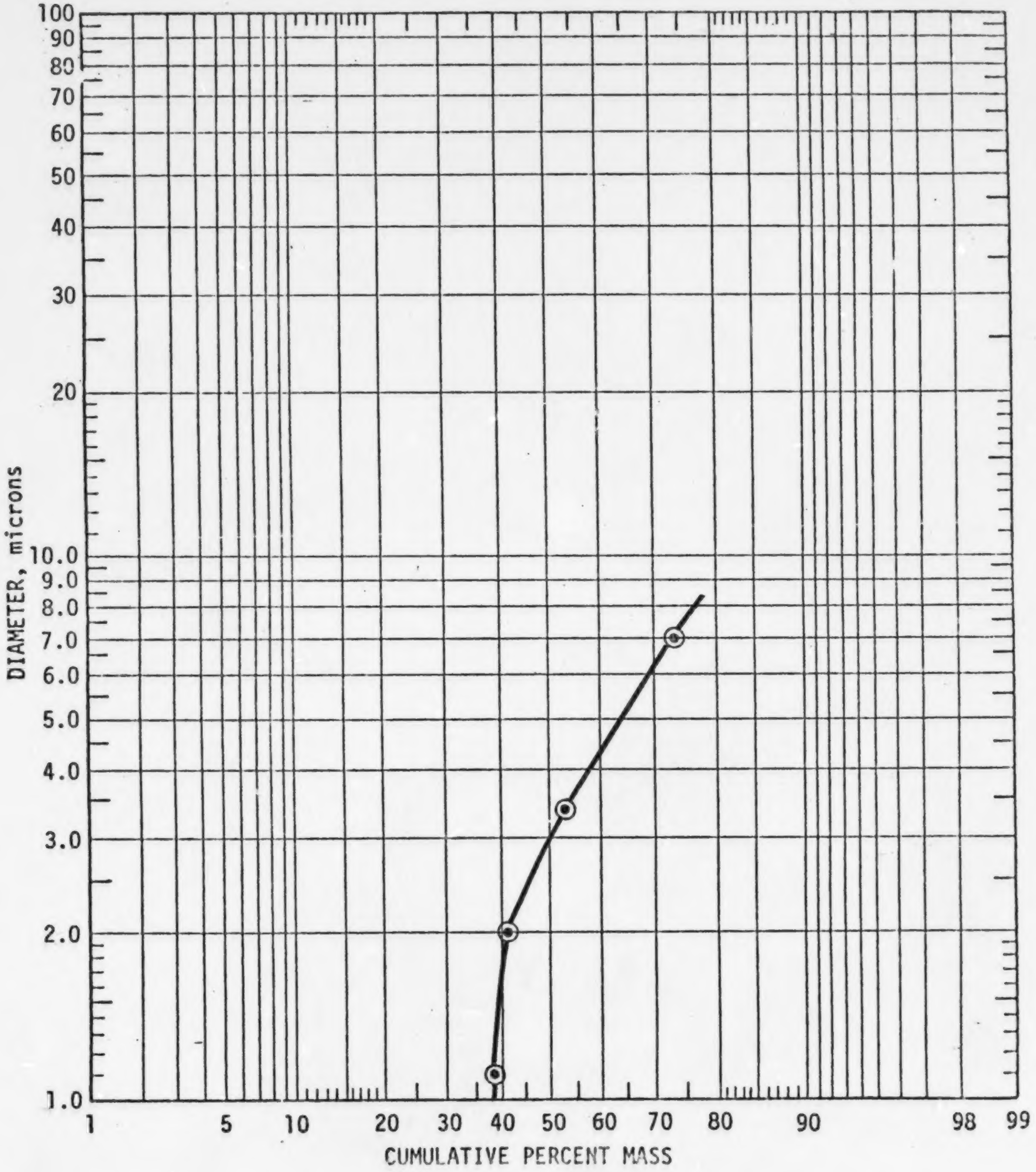


Figure 3-2. Andersen Cascade Size Distribution for Las Vegas, Site Sunrise Power Plant, sampling period 4/1/76 (48 hrs.).

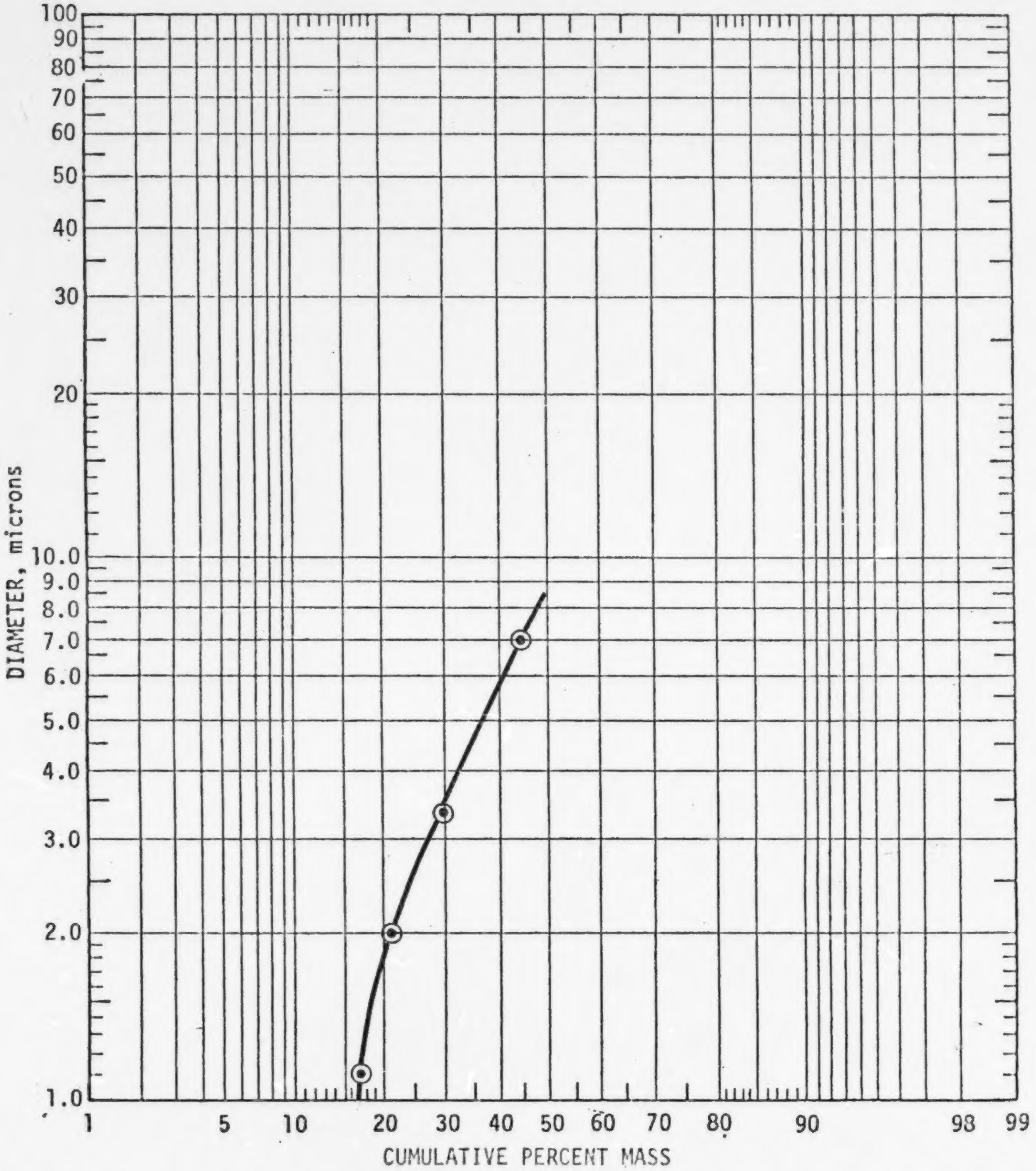


Figure 3-3. Andersen Cascade Size Distribution for Las Vegas Site Sunrise Power Plant, sampling period 4/18/76 (48 hrs.).

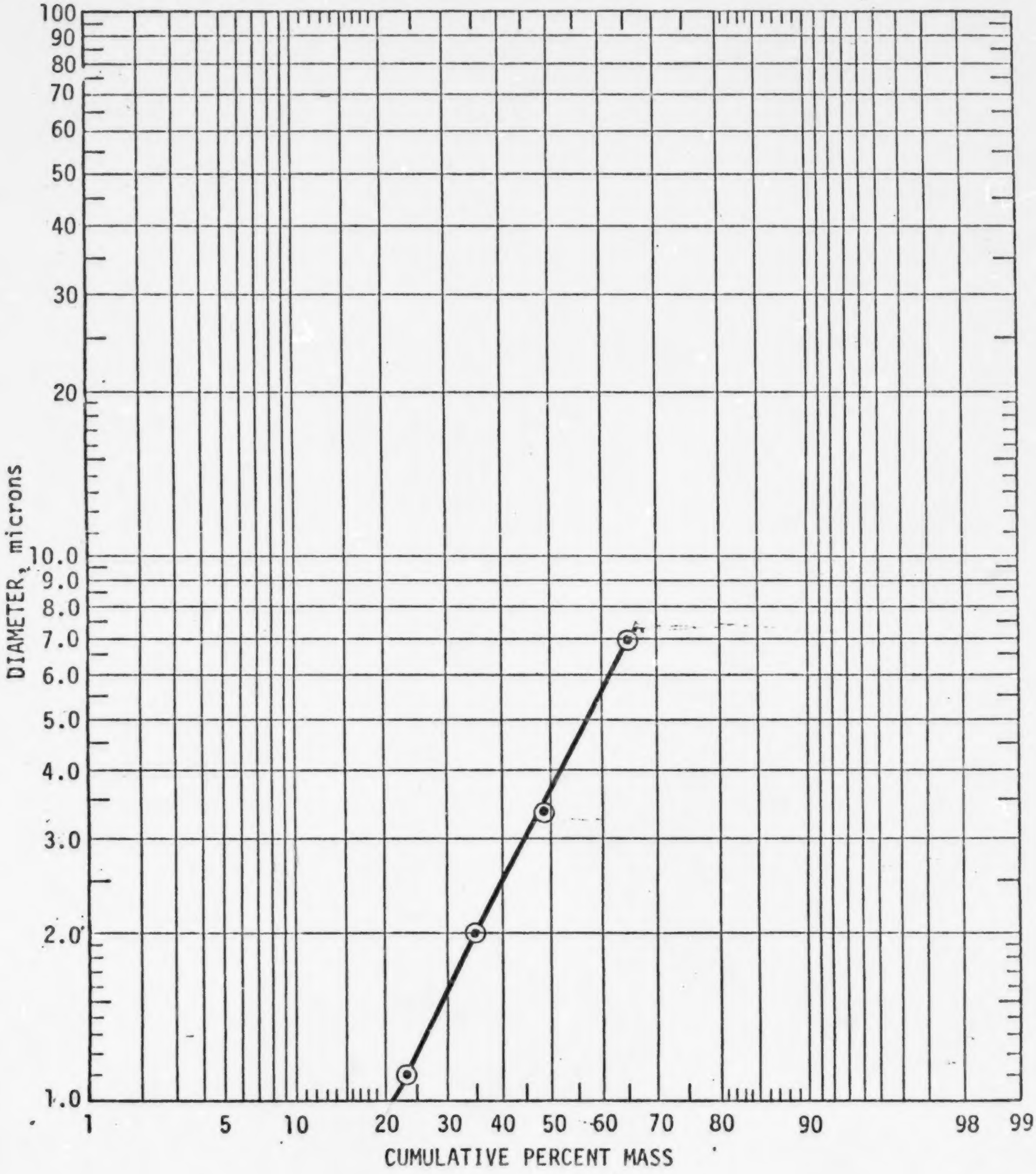


Figure 3-4. Andersen Cascade Size Distribution for Las Vegas Site Sunrise Power Plant, sampling period 4/24/76 (48 hrs.).

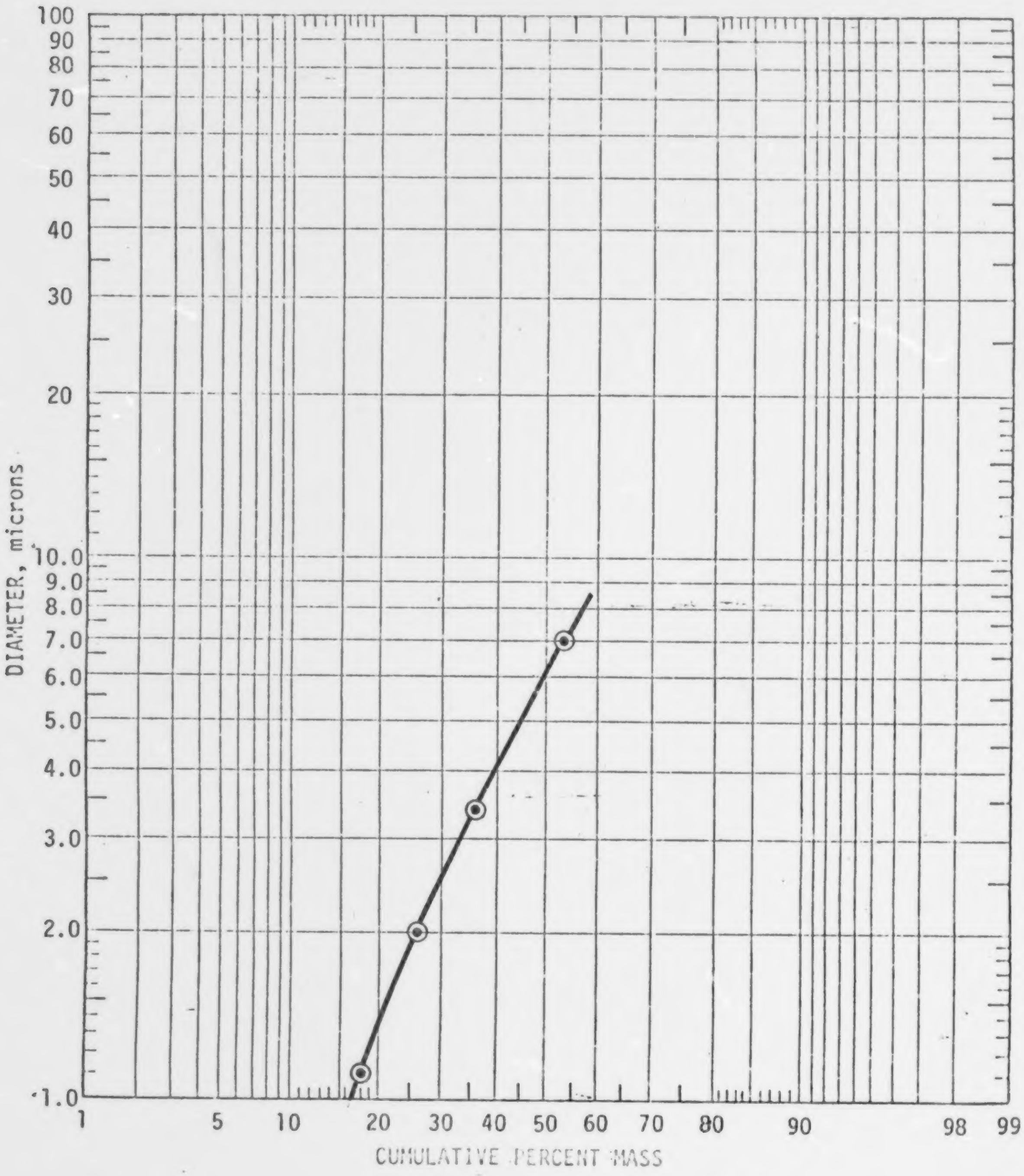


Figure 3-5. Andersen Cascade Size Distribution for Las Vegas Site Sahara Hotel, sampling period 4/6/76 (48 hrs.).

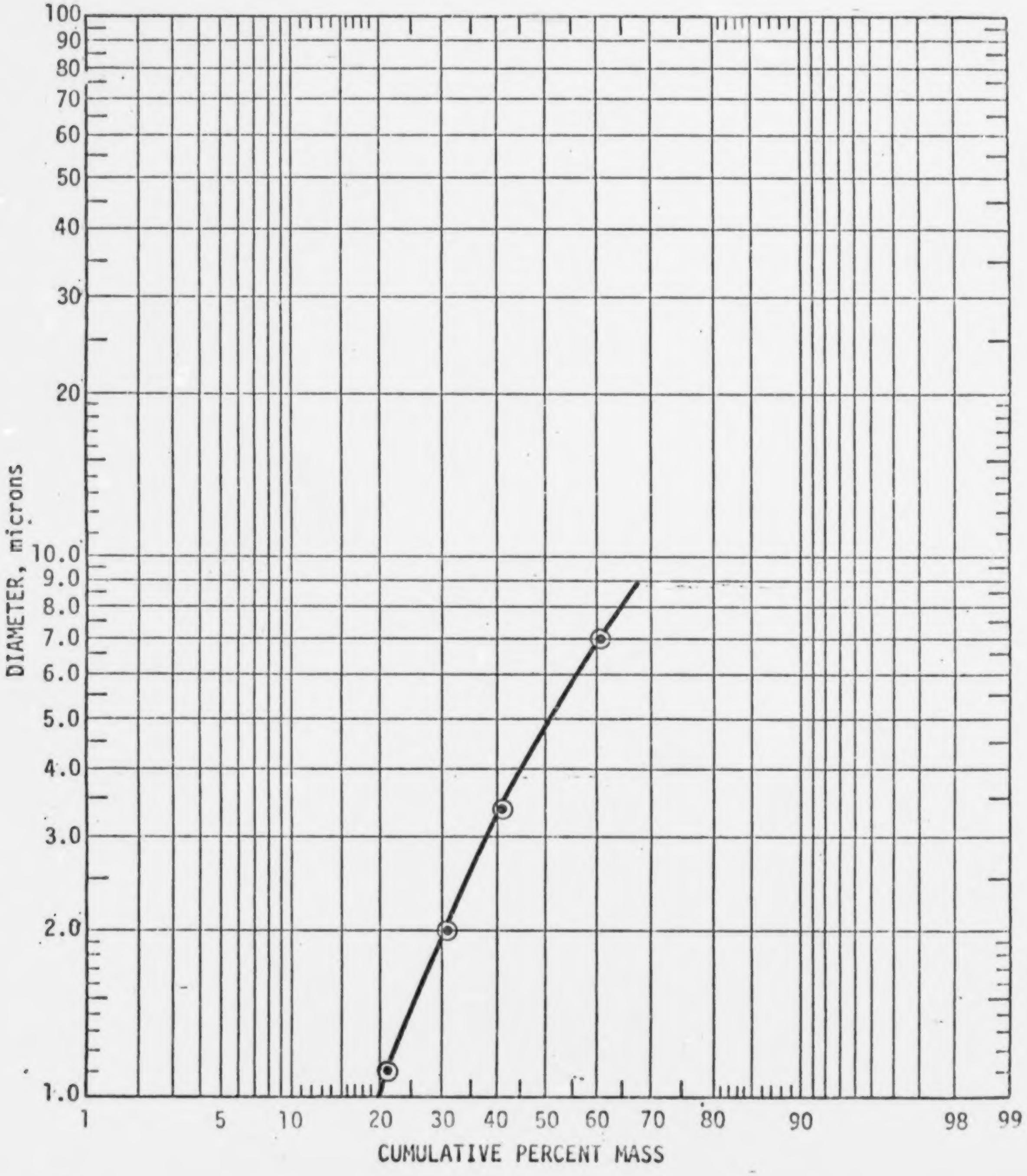


Figure 3-6. Andersen Cascade Size Distribution for Las Vegas Site Sahara Hotel, sampling period 4/12/76 (48 hrs.).

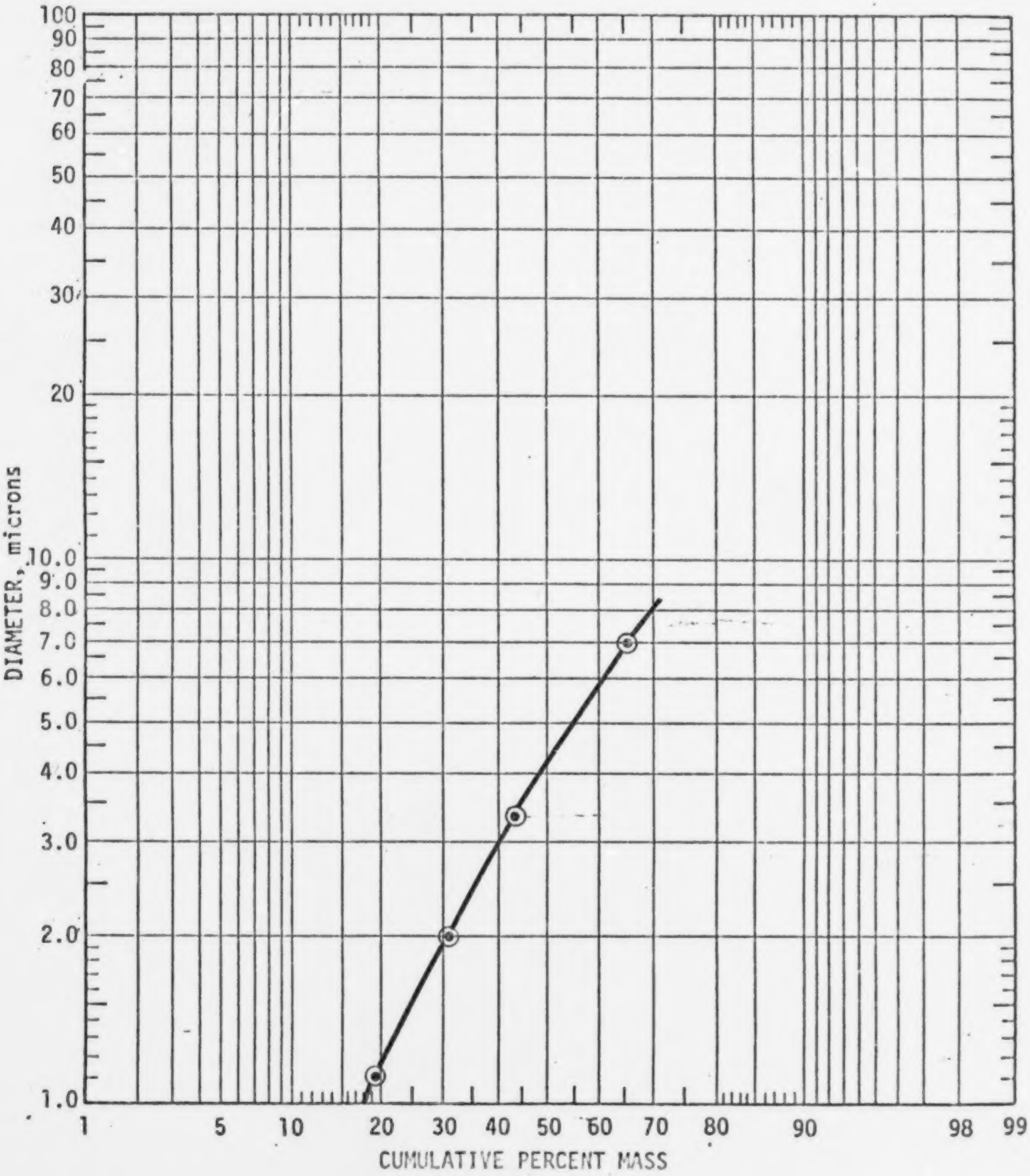


Figure 3-7. Andersen Cascade Size Distribution for Las Vegas Site Sahara Hotel, sampling period 4/18/76 (48 hrs.).

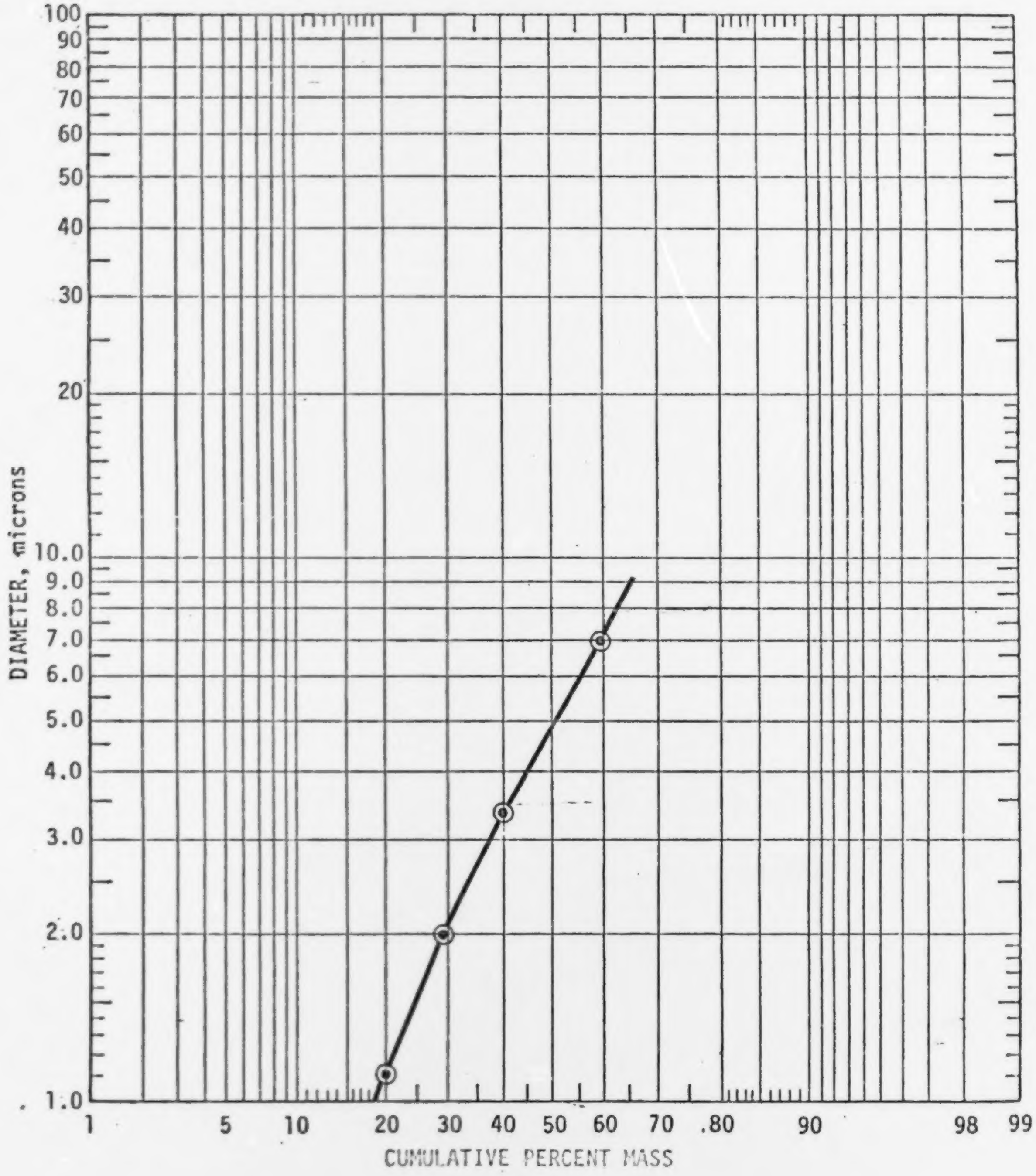
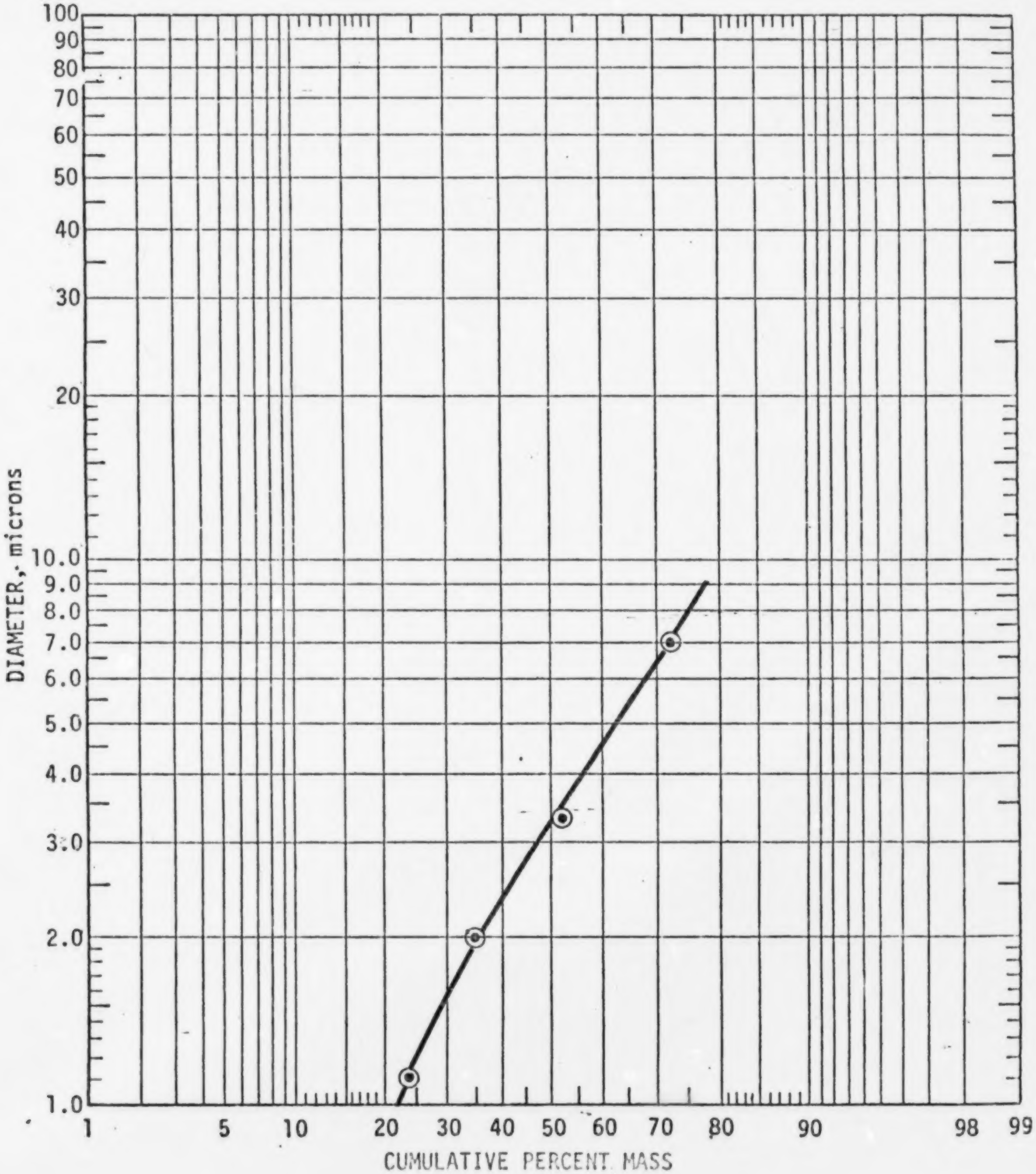


Figure 3-8. Andersen Cascade Size Distribution for Las Vegas Site Sahara Hotel, sampling period 4/24/76 (48 hrs.).



4. SUMMARY OF DATA FOR RENO

Tables 4-1 through 4-17 presents the percent size distribution by both number and weight for the three classes of particulate matter as determined from the glass fiber and millipore hi-vol filters. The summaries are given for each individual sampling station for the entire sampling period and across all sampling stations for each sampling date. When analyzing the data, the particle size distributions from the glass fiber and the millipore filters can not be expected to be the same since the air flow through the millipore is one-half the flow through the glass fiber filters. The difference in air flow rates will affect the size distribution of dust collected on the filters.

Table 4-18 presents the chemical results for the soil samples. Figures 4-1 through 4-3 shows the particle size distributions as determined by the Andersen Cascade Impactors.

Table 4-1. RENO GLASS FIBER FILTERS AT HEALTH DEPARTMENT

Station: Health Dept.

Dates of Collection: April 12, 24, 1976

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	87	2.0	0.00	3.7	0.22	0.00
3.7- 5.3	4.6	0.36	0.00	2.8	0.56	0.00
5.3- 7.4	2.1	0.34	0.00	3.6	1.5	0.00
7.4-10.5	1.2	0.37	0.01	5.8	4.7	0.00
10.5-14.9	0.55	0.31	0.08	7.6	11	0.11
14.9-21.0	0.29	0.20	0.06	11	20	0.23
21.0-29.7	0.11	0.01	0.02	11	3.3	0.26
29.7-42.0	0.04	0.00	0.01	11	0.00	0.37
42.0-59.4	0.00	0.00	0.01	0.00	0.00	1.0
>59.4	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal	96	3.6	0.19	56	41	2.0
Total	100			99		

Chemical Analysis

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	0.32	0.32	0.33
Combustibles	0.70	0.40	1.10
Silicates*			
TSP**	39.3	32.9	45.7

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-2. RENO GLASS FIBER FILTERS AT CAL-NEVA CLUB

Station: Cal-Neva Club

Dates of Collection: April 6, 12, 18, 24, 30, 1976

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	83	5.6	0.00	2.8	0.49	0.00
3.7- 5.3	6.0	0.64	0.00	2.9	0.80	0.00
5.3- 7.4	2.0	0.27	0.00	2.7	0.93	0.00
7.4-10.5	0.87	0.19	0.07	3.3	1.8	0.03
10.5-14.9	0.42	0.11	0.09	4.5	3.2	0.10
14.9-21.0	0.18	0.06	0.09	5.4	4.8	0.28
21.0-29.7	0.12	0.03	0.05	11	6.0	0.48
29.7-42.0	0.06	0.02	0.02	15	11	0.46
42.0-59.4	0.02	0.00	0.01	13	3.0	0.36
>59.4	0.00	0.00	0.00	1.2	6.0	0.00
Subtotal	92	6.9	0.33	62	38	2.0
Total	99			102		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	0.74	0.47	1.22
Combustibles	3.00	1.40	6.10
Silicates*			
TSP**	61.9	43.1	84.2

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-3. RENO GLASS FIBER FILTERS AT SPARKS NUGGET

Station: Sparks Nugget

Dates of Collection: April 6, 12, 18 24, 30, 1976

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	78	9.7	0.00	2.6	0.83	0.00
3.7- 5.3	5.5	1.6	0.00	2.5	1.9	0.00
5.3- 7.4	2.1	0.70	0.01	2.7	2.4	0.00
7.4-10.5	0.77	0.28	0.11	2.9	2.7	0.04
10.5-14.9	0.38	0.12	0.12	4.0	3.2	0.13
14.9-21.0	0.18	0.06	0.08	5.3	4.8	0.24
21.0-29.7	0.07	0.03	0.04	5.9	6.0	0.39
29.7-42.0	0.05	0.01	0.02	11	5.0	0.43
42.0-59.4	0.02	0.00	0.01	15	5.6	0.78
>59.4	0.00	0.01	0.00	2.2	11	0.22
Subtotal	87	13	0.39	54	43	2.0
Total	100			99		

Chemical Analysis

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	0.85	0.46	1.58
Combustibles	2.3	1.5	3.2
Silicates*			
TSP**	69	45.8	108.3

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-4. RENO MILLIPORE FILTERS AT HEALTH DEPARTMENT

Station: Health Dept.

Dates of Collection: April 6, 12, 18, 24, 30, 1976

Filter Type: Millipore

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	79	6.2	0.00	1.6	0.33	0.00
3.7- 5.3	6.1	0.97	0.00	1.8	0.73	0.00
5.3- 7.4	2.5	0.54	0.00	2.0	1.1	0.00
7.4-10.5	1.3	0.34	0.20	3.0	2.0	0.05
10.5-14.9	0.71	0.24	0.17	4.6	4.1	0.11
14.9-21.0	0.44	0.15	0.11	8.2	7.1	0.21
21.0-29.7	0.21	0.07	0.06	11	9.6	0.34
29.7-42.0	0.05	0.04	0.03	8.0	17	0.42
42.0-59.4	0.01	0.01	0.01	6.0	9.1	0.46
>59.4	0.00	0.00	0.00	1.0	0.00	0.10
Subtotal	90	8.6	0.58	47	51	1.7
Total	99			100		

Chemical Analysis ***

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	0.39	0.19	0.70
Lead	0.35	0.21	0.63
Combustibles	11	1.4	25
Silicates*	1.7	0.7	3.3
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

*** April air volume not received. Data not included in Chemistry Summary.

Table 4-5. RENO MILLIPORE FILTERS AT CAL-NEVA CLUB

Station: Cal-Neva Culb

Dates of Collection: April 6, 12, 18, 24, 30, 1976

Filter Type: Millipore

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	91	2.3	0.00	5.9	0.39	0.00
3.7- 5.3	3.5	0.37	0.00	3.2	0.90	0.00
5.3- 7.4	1.1	0.18	0.00	3.0	1.2	0.00
7.4-10.5	0.54	0.07	0.13	4.0	1.3	0.10
10.5-14.9	0.27	0.05	0.08	5.6	24	0.16
14.9-21.0	0.17	0.04	0.05	10	5.5	0.31
21.0-29.7	0.06	0.02	0.02	10	10	0.32
29.7-42.0	0.02	0.01	0.01	9.3	8.6	0.36
42.0-59.4	0.01	0.00	0.01	12	2.7	1.0
>59.4	0.00	0.00	0.00	1.0	0.00	0.21
Subtotal	97	3.0	0.30	64	33	2.5
Total	100			100		

Chemical Analysis ***

Constituent	Concentration, $\mu g/m^3$		
	Average	Low	High
Calcium	0.95	0.85	1.05
Lead	0.99	0.66	1.32
Combustibles	15	6.6	24
Silicates*	10.5	9.3	11.8
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

*** April 12, 18, 30 air volumes not received. Data not included in Chemistry Summary.

Table 4-6. RENO MILLIPORE FILTERS AT SPARKS NUGGET

Station: Sparks Nugget

Dates of Collection: April 6, 12, 18, 24, 30, 1976

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	84	5.0	0.00	2.0	0.31	0.00
3.7- 5.3	5.0	0.71	0.00	1.7	0.62	0.00
5.3- 7.4	2.0	0.37	0.00	1.9	0.90	0.00
7.4-10.5	1.1	0.17	0.11	3.0	1.2	0.03
10.5-14.9	0.66	0.15	0.10	5.0	2.9	0.07
14.9-21.0	0.36	0.10	0.08	7.7	5.1	0.17
21.0-29.7	0.20	0.06	0.04	12	9.0	0.28
29.7-42.0	0.10	0.02	0.03	17	8.3	0.50
42.0-59.4	0.03	0.00	0.02	14	3.4	0.76
>59.4	0.00	0.00	0.01	1.3	0.00	0.22
Subtotal	93	6.6	0.39	66	32	2.0
Total	100			100		

Chemical Analysis***

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	0.66	0.28	1.10
Lead	0.91	0.48	1.66
Combustibles	15	<1	25
Silicates*	5.4	3.6	8.7
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

*** April 18 air volume not received. Data not inculded in Chemistry Summary.

Table 4-7. RENO GLASS FIBER FILTERS ON APRIL 6, 1976

Date: April 6, 1976

Collecting Stations: Cal-Neva, Sparks Nugget

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	83	6.1	0.00	2.5	0.48	0.00
3.7- 5.3	5.4	0.60	0.00	2.3	0.67	0.00
5.3- 7.4	2.0	0.18	0.01	2.4	0.58	0.00
7.4-10.5	0.82	0.11	0.09	2.8	0.95	0.03
10.5-14.9	0.40	0.10	0.13	3.8	2.6	0.13
14.9-21.0	0.23	0.05	0.08	6.2	3.4	0.22
21.0-29.7	0.10	0.03	0.04	7.4	6.2	0.32
29.7-42.0	0.07	0.02	0.01	14	10	0.17
42.0-59.4	0.02	0.00	0.00	14	6.0	0.00
>59.4	0.00	0.01	0.00	0.00	12	0.00
Subtotal	92	7.2	0.36	55	43	0.88
Total	100			99		

Chemical Analysis

Constituent	Concentration, $\mu g/m^3$		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	0.73	0.64	0.82
Combustibles	1.60	1.40	1.90
Silicates*			
TSP**	61.8	59.9	63.8

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-8. RENO GLASS FIBER FILTERS ON APRIL 12, 1976

Date: April 12, 1976

Collecting Stations: Cal-Neva, Health Department, Sparks Nugget

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	83	5.9	0.00	2.8	0.53	0.00
3.7- 5.3	5.8	0.34	0.00	2.8	0.42	0.00
5.3- 7.4	2.0	0.15	0.00	2.7	0.53	0.00
7.4-10.5	1.1	0.13	0.05	4.0	1.3	0.02
10.5-14.9	0.53	0.08	0.09	5.9	2.2	0.10
14.9-21.0	0.22	0.05	0.07	6.9	3.9	0.23
21.0-29.7	0.14	0.01	0.03	12	2.6	0.23
29.7-42.0	0.06	0.01	0.03	15	7.4	0.66
42.0-59.4	0.03	0.00	0.01	18	5.2	0.42
>59.4	0.01	0.00	0.00	4.0	0.00	0.00
Subtotal	93	6.7	0.28	74	24	1.7
Total	100			100		

Chemical Analysis

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	0.46	0.33	0.59
Combustibles	1.50	0.40	2.00
Silicates*			
TSP**	41.7	32.9	49.2

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-9. RENO GLASS FIBER FILTERS ON APRIL 18, 1976

Date: April 18, 1976

Collecting Stations: Cal-Neva, Sparks Nugget

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	75	14	0.00	3.2	1.6	0.00
3.7- 5.3	4.6	2.0	0.00	2.8	3.2	0.00
5.3- 7.4	1.5	0.86	0.00	2.6	3.9	0.00
7.4-10.5	0.46	0.31	0.07	2.2	3.9	0.03
10.5-14.9	0.24	0.13	0.07	3.3	4.6	0.10
14.9-21.0	0.10	0.06	0.05	4.1	5.9	0.19
21.0-29.7	0.07	0.03	0.04	7.2	8.4	0.41
29.7-42.0	0.03	0.01	0.01	8.0	8.9	0.23
42.0-59.4	0.02	0.00	0.01	16	0.00	0.99
>59.4	0.00	0.00	0.00	0.00	8.4	0.00
Subtotal	82	17	0.25	49	49	2.0
Total	99			100		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	0.60	0.46	0.75
Combustibles	3.8	1.5	6.1
Silicates*			
TSP**	53.4	45.8	61.1

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-10. RENO GLASS FIBER FILTERS ON APRIL 24, 1976

Date: April 24, 1976

Collecting Stations: Sparks, Cal-Neva, Health Department

Filter Type: Glass Fiber

Microscopic Analysis

	Particle size distribution					
	Percent by number			Percent by weight		
Particle size, µm	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	82	3.8	0.00	2.8	0.34	0.00
3.7- 5.3	6.9	0.89	0.00	3.4	1.1	0.00
5.3- 7.4	2.6	0.74	0.00	3.5	2.6	0.00
7.4-10.5	0.95	0.57	0.10	3.7	5.8	0.04
10.5-14.9	0.35	0.28	0.12	3.9	8.0	0.14
14.9-21.0	0.15	0.17	0.12	4.6	14	0.40
21.0-29.7	0.05	0.04	0.08	4.4	9.1	0.72
29.7-42.0	0.02	0.00	0.02	5.0	3.2	0.64
42.0-59.4	0.00	0.00	0.00	3.5	9.1	0.36
>59.4	0.00	0.00	0.00	0.00	9.1	0.36
Subtotal	93	6.5	0.44	35	62	2.7
Total	100			100		

Chemical Analysis

	Concentration, µg/m^3		
Constituent	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	0.57	0.32	0.78
Combustibles	2.4	1.1	3.3
Silicates*			
TSP**	61.7	45.7	77.9

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-11. RENO GLASS FIBER FILTERS ON APRIL 30, 1976

Date: April 30, 1976

Collecting Stations: Sparks, Cal-Neva

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	80	5.8	0.00	2.2	0.42	0.00
3.7- 5.3	5.9	1.9	0.00	2.4	2.0	0.00
5.3- 7.4	2.5	0.65	0.00	2.8	1.9	0.00
7.4-10.5	0.95	0.20	0.15	3.0	1.6	0.05
10.5-14.9	0.49	0.10	0.11	4.4	2.3	0.10
14.9-21.0	0.20	0.05	0.11	5.1	3.4	0.30
21.0-29.7	0.12	0.02	0.08	8.4	4.4	0.56
29.7-42.0	0.08	0.01	0.03	17	5.0	0.59
42.0-59.4	0.02	0.00	0.02	14	0.00	1.4
>59.4	0.00	0.01	0.00	2.7	14	0.28
Subtotal	90	8.7	0.5	62	35	3.3
Total	99			100		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	1.40	1.22	1.58
Combustibles	2.7	2.2	3.2
Silicates*			
TSP**	96.2	84.2	108.3

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-12. RENO MILLIPORE FILTERS ON APRIL 6, 1976

Date: April 6, 1976

Collecting Stations: Sparks, Cal-Neva, Health Department

Filter Type: Millipore

Microscopic Analysis

Particle size, μm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	82	5.5	0.00	2.6	0.45	0.00
3.7- 5.3	5.6	0.93	0.00	2.5	1.1	0.00
5.3- 7.4	2.3	0.40	0.00	2.9	1.3	0.00
7.4-10.5	1.2	0.18	0.12	4.4	1.6	0.04
10.5-14.9	0.62	0.11	0.14	6.2	2.9	0.14
14.9-21.0	0.36	0.10	0.07	10	7.2	0.22
21.0-29.7	0.15	0.03	0.05	12	6.5	0.39
29.7-42.0	0.06	0.01	0.02	13	6.5	0.48
42.0-59.4	0.02	0.00	0.01	12	2.6	0.93
>59.4	0.00	0.00	0.01	2.0	0.00	0.31
Subtotal	92	7.3	0.42	68	30	2.5
Total	100			101		

Chemical Analysis ***

Constituent	Concentration, μg/m^3		
	Average	Low	High
Calcium	0.96	0.87	1.05
Lead	1.01	0.70	1.32
Combustibles	24	24	25
Silicates*	10.2	8.7	11.8
TSP**			

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters
*** Health Department data not included, no air volume.

Table 4-13. RENO MILLIPORE FILTERS ON APRIL 12, 1976

Date: April 12, 1976

Collecting Stations: Cal-Neva, Sparks, Health Department

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	93	1.4	0.00	9.2	0.36	0.00
3.7- 5.3	3.2	0.25	0.00	4.5	0.90	0.00
5.3- 7.4	1.0	0.16	0.00	4.0	1.7	0.00
7.4-10.5	0.40	0.08	0.13	4.5	2.2	0.15
10.5-14.9	0.17	0.04	0.07	5.3	3.4	0.24
14.9-21.0	0.12	0.04	0.05	10	8.4	0.44
21.0-29.7	0.03	0.02	0.02	7.9	11	0.44
29.7-42.0	0.01	0.00	0.00	7.2	5.1	0.20
42.0-59.4	0.00	0.00	0.01	5.6	4.8	1.2
>59.4	0.00	0.00	0.00	0.93	0.00	0.19
Subtotal	98	2.0	0.28	59	38	2.9
Total	100			100		

Chemical Analysis***

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	0.28	0.19	0.37
Lead	0.34	0.21	0.48
Combustibles	2.3	1.1	3.6
Silicates*	0.7	<1	1.4
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

*** Cal-Neva data not included, no air volume.

Table 4-14. RENO MILLIPORE FILTERS ON APRIL 18, 1976

Date: April 18, 1976

Collecting Stations: Sparks, Cal-Neva, Health Department

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	82	5.2	0.00	1.1	0.19	0.00
3.7- 5.3	5.5	0.94	0.00	1.1	0.48	0.00
5.3- 7.4	2.2	0.58	0.00	1.2	0.83	0.00
7.4-10.5	1.1	0.32	0.22	1.7	1.3	0.04
10.5-14.9	0.60	0.30	0.11	2.6	3.5	0.05
14.9-21.0	0.39	0.21	0.10	4.9	6.7	0.13
21.0-29.7	0.20	0.14	0.04	7.3	13	0.14
29.7-42.0	0.10	0.09	0.02	10	24	0.25
42.0-59.4	0.04	0.01	0.02	10	8.2	0.60
>59.4	0.00	0.00	0.00	0.00	0.00	0.11
Subtotal	92	7.8	0.51	40	58	1.3
Total	100			99		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	0.38	-***	-
Lead	0.28	-	-
Combustibles	13	-	-
Silicates*	0.7	-	-
TSP**			

* Not applicable to Glass Fiber Filters

** Not applicable to Millipore Filters

*** Data for Health Dept. only. No air volumes for other stations received.

Table 4-15. RENO MILLIPORE FILTERS ON APRIL 24, 1976

Date: April 24, 1976

Collecting Stations: Cal-Neva, Health Department, Sparks

Filter Type: Millipore

Microscopic Analysis

	Particle size distribution					
	Percent by number			Percent by weight		
Particle size, µm	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	81	6.5	0.00	2.0	0.41	0.00
3.7- 5.3	5.6	0.72	0.00	2.0	0.65	0.00
5.3- 7.4	2.1	0.28	0.01	2.1	0.71	0.00
7.4-10.5	1.2	0.12	0.15	3.4	0.85	0.04
10.5-14.9	0.69	0.12	0.14	5.5	2.4	0.11
14.9-21.0	0.37	0.06	0.09	8.3	3.6	0.21
21.0-29.7	0.25	0.05	0.06	16	8.0	0.41
29.7-42.0	0.10	0.01	0.04	17	6.6	0.78
42.0-59.4	0.03	0.00	0.01	13	2.7	0.74
>59.4	0.00	0.00	0.01	2.0	0.00	0.42
Subtotal	91	7.9	0.51	71	26	2.7
Total	99			100		

Chemical Analysis

	Concentration, µg/m^3		
Constituent	Average	Low	High
Calcium	0.48	0.28	0.85
Lead	0.59	0.30	0.80
Combustibles	9.8	4.7	18
Silicates*	5.2	1.8	9.3
TSP**			

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-16. RENO MILLIPORE FILTERS ON APRIL 30, 1976

Date: April 30, 1976

Collecting Stations: Cal-Neva, Sparks, Health Department

Filter Type: Millipore

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	82	6.2	0.00	2.1	0.41	0.00
3.7- 5.3	5.0	0.85	0.00	1.8	0.74	0.00
5.3- 7.4	2.1	0.42	0.00	2.2	1.1	0.00
7.4-10.5	1.3	0.22	0.12	3.7	1.6	0.04
10.5-14.9	0.87	0.15	0.10	7.1	3.2	0.09
14.9-21.0	0.50	0.07	0.09	12	4.2	0.21
21.0-29.7	0.24	0.04	0.05	16	6.4	0.31
29.7-42.0	0.07	0.01	0.03	14	4.9	0.58
42.0-59.4	0.02	0.00	0.01	13	3.9	0.47
>59.4	0.00	0.00	0.00	1.5	0.00	0.00
Subtotal	92	8.0	0.40	73	26	1.7
Total	100			101		

Chemical Analysis***

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	0.90	0.70	1.10
Lead	1.14	0.63	1.66
Combustibles	22	19	25
Silicates*	4.1	3.3	5.0
TSP**			

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters
*** Cal-Neva data not included, no air volume received.

Table 4-17. RENO HISTORICAL GLASS FIBER FILTERS

Station: Historical

Dates of Collection: January 7, February 12, 1976

Filter Type: Glass Fiber

Microscopic Analysis

Particle size, µm	Particle size distribution					
	Percent by number			Percent by weight		
	Combust.	Mineral	Tire Abr.	Combust.	Mineral	Tire Abr.
<3.7	77	4.1	0.00	1.1	0.15	0.00
3.7- 5.3	8.2	0.49	0.00	1.6	0.25	0.00
5.3- 7.4	3.5	0.22	0.00	2.0	0.32	0.00
7.4-10.5	2.2	0.14	0.10	3.5	0.57	0.02
10.5-14.9	1.5	0.09	0.11	6.6	1.1	0.05
14.9-21.0	0.86	0.07	0.11	11	2.3	0.14
21.0-29.7	0.46	0.03	0.10	16	2.5	0.38
29.7-42.0	0.19	0.02	0.06	19	6.3	0.66
42.0-59.4	0.06	0.00	0.03	16	2.0	0.00
>59.4	0.02	0.00	0.01	4.6	0.99	0.00
Subtotal	94	5.2	0.52	81	16	1.2
Total	100			98		

Chemical Analysis

Constituent	Concentration, µg/m^3		
	Average	Low	High
Calcium	<0.01	<0.01	<0.01
Lead	2.69	2.04	3.33
Combustibles	12.9	9.8	18.9
Silicates*			
TSP**	231.6	134.7	360.5

* Not applicable to Glass Fiber Filters
** Not applicable to Millipore Filters

Table 4-18. SUMMARY OF RENO SOIL ANALYSES

Sample	Site	Ca mg/g	Pb mg/g	SiO_2 mg/g	Combust. mg/g
1	200 yards south of I-80 at Kleepe Lane	1.01	0.02	475	79.0
2	E. Glendale Rd. at Merideth Way	1.21	0.117	425	134.0
3	N.E. corner of E. Glendale Rd. at Bergin Way	10.8	0.03	472	65.6
4	E. Glendale Rd. at Industrial Way	0.623	0.20	465	79.6
5	E. Glendale Rd. at Galletti Way	1.74	0.469	503	59.8
6	Kuenzli Ln. at Manual	1.30	0.989	432	28.4
7	Lake St. and Plaza	0.707	1.89	461	67.0
8	W. 2nd St. and Arletta Way	0.466	0.48	381	45.9
9	1/2 mile west of city limit on Rt. 40	0.996	0.07	629	30.9
10	Twin Lakes Dr., 0.4 mile north of Rt. 40	0.811	0.03	563	100.4
11	Rt. 395 and Parr Blvd.	0.24	0.07	587	76.7
12	Rt. 395 and Oddie Blvd.	11.1	0.06	553	88.4
13	Colonly Rd. at E. 2nd St.	1.48	1.65	435	41.4
14	(Sample vial not numbered)	-	-	-	-
15	South-west corner Kietzke at Moana Ln.	0.842	0.02	517	53.5

Table 4-18 (continued). SUMMARY OF RENO SOIL ANALYSES

Sample	Site	Ca mg/g	Pb mg/g	SiO_2 mg/g	Combust. mg/g
16	South-west corner S. Virginia at Hash Ln.	0.16	0.14	553	111.7
17	South-west corner Rock Blvd. at Boynton Ln.	6.8	0.04	493	79.4
18	Pyramid Rd. at Queen Way	0.31	0.15	583	53.1
19	(Sample vial not numbered)	-	-	-	-
20	Plumb Ln. at Ferris Ln.	0.14	0.12	577	97.0

Figure 4-1. Andersen Cascade Size Distribution for Reno Site Sparks Nugget, sampling period 4/6/76 (48 hrs.).

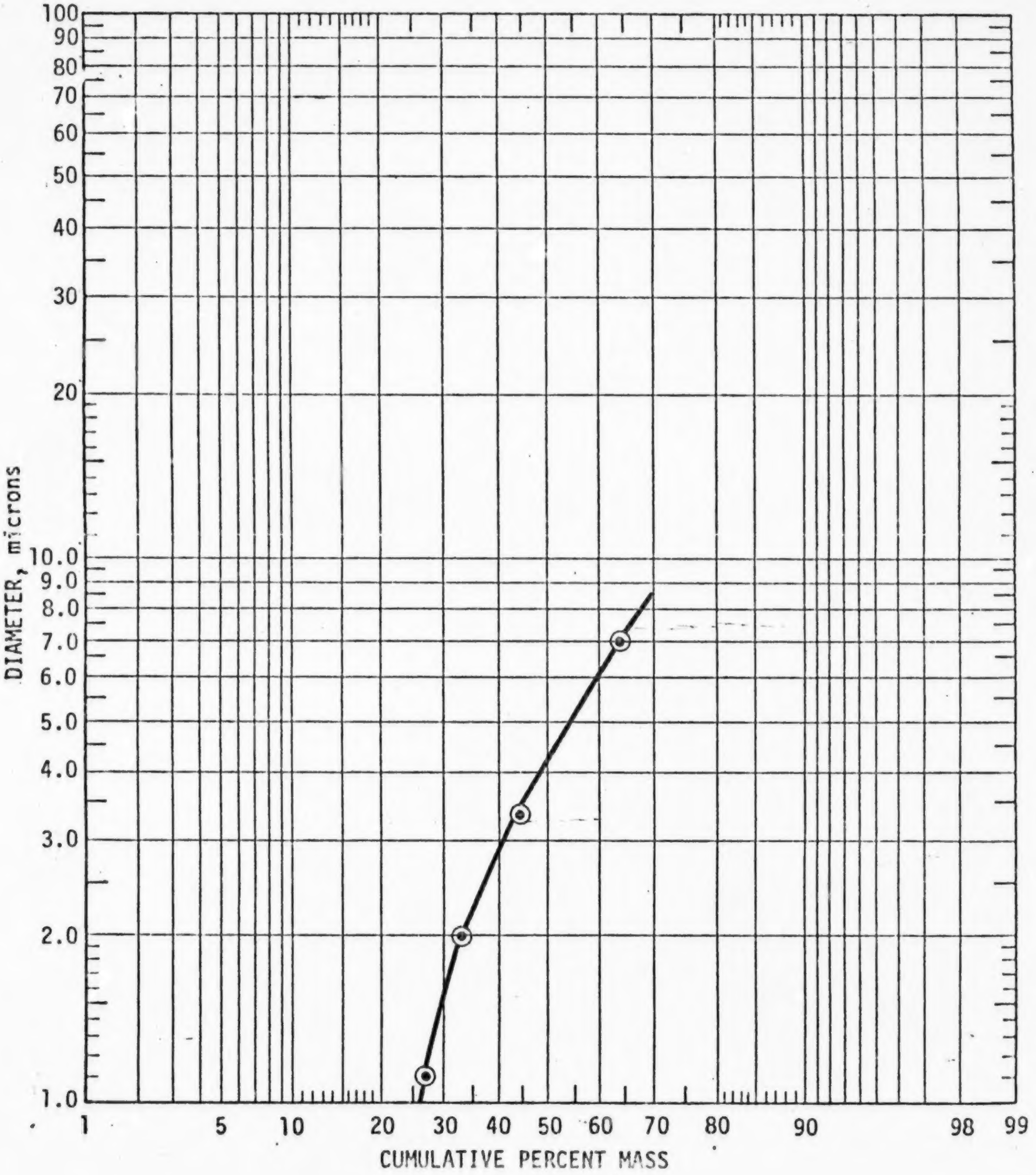


Figure 4-2. Andersen Cascade Size Distribution for Reno Site Sparks Nugget, sampling period 4/18/76 (48 hrs.).

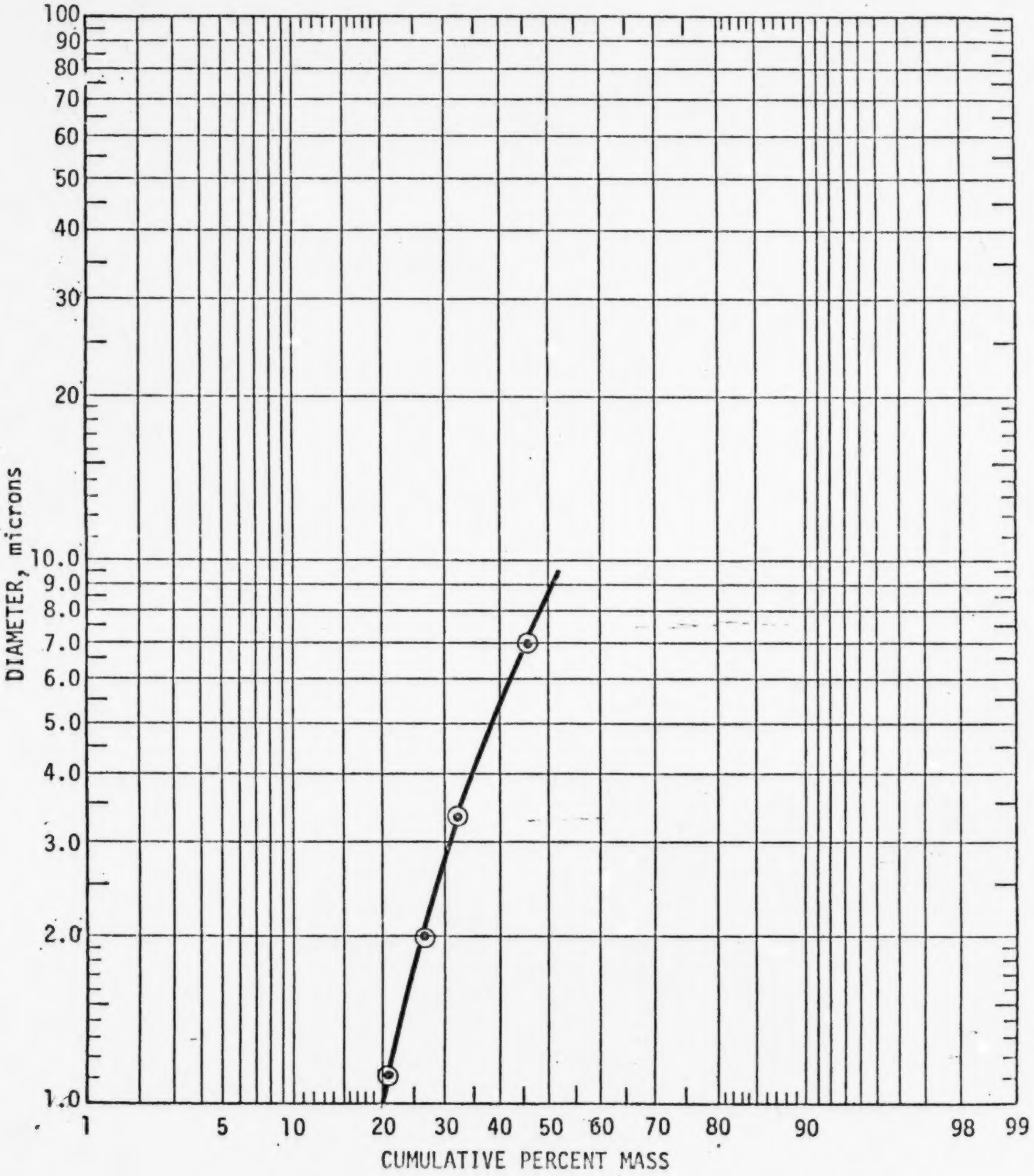
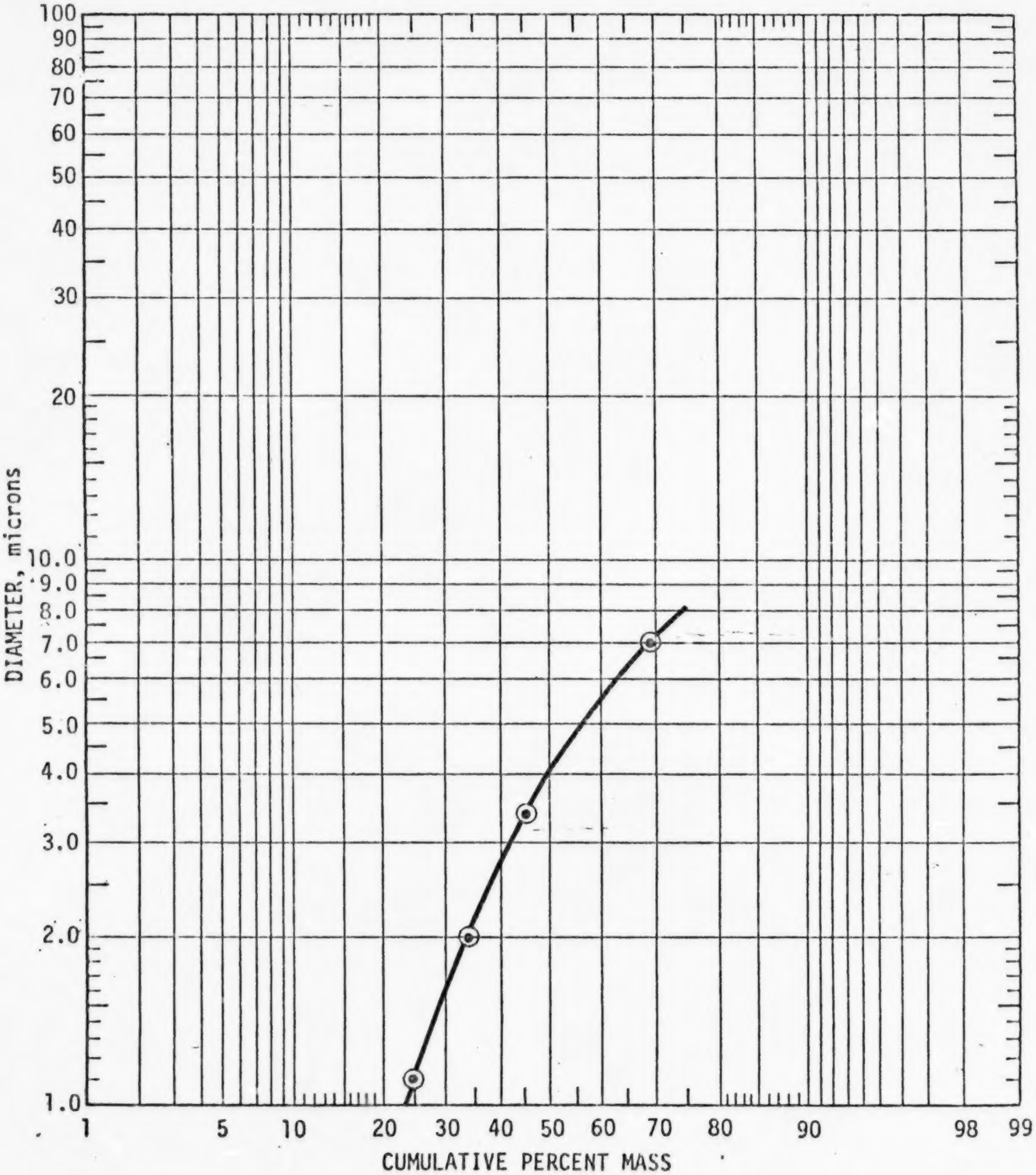


Figure 4-3. Andersen Cascade Size Distribution for Reno Site Sparks Nugget, sampling period 4/30/76 (48 hrs.).



5. FUGITIVE EMISSIONS IMPACT FACTOR

A primary purpose of this study was to determine if a reasonable relationship could be developed, for each AQCR, between the principal fugitive dust emission category (mineral) and the percent by weight of mineral particulates identified by means of microscopic examination of both the glass fiber and cellulose acetate filters. If such a relationship exists, a "weighing" factor can be developed which would provide a much more accurate definition of the beneficial impact on air quality, which results from specific emission reduction control strategies.

From the microinventory of selected sites in Las Vegas and Reno, all emissions were identified and classified as being from mineral, tire wear, or combustion sources, as shown in Appendix A. Also taken at these sites were high-volume samples (millipore and glass fiber), which were analyzed for the percent by weight of material from the same source classifications (see Chapter 4). The mineral percentage by weight of both the emissions and the filter loadings are shown in Table 5-1.

It has been observed that a high percentage of all microinventory emissions at the selected sites are from mineral sources. One would expect a similar percentage of minerals to appear on the sample filters. This, however, was not the case. The ratio of percentage of minerals sampled to percentage of minerals emitted is approximately 0.60. Because of this large disparity, a reduction in mineral emissions cannot be expected to result in an equal reduction in filter loadings. Since the control strategies

Table 5-1. FUGITIVE DUST WEIGHING FACTORS

AQCR/ Filter media	Site	% Mineral emissions (Micro-inventory)	% Mineral air quality (microscopic)	Ratio of air quality/ emissions	Weighing factor
Las Vegas/ Glass Fiber	Sahara	91	51	0.56	
	Henderson	96	70	0.73	
	Sunrise	99	75	0.76	0.68
Las Vegas/ Millipore	Sahara	91	42	0.46	
	Henderson	96	61	0.64	
	Sunrise	99	70	0.71	0.60
Reno/ Glass Fiber	Health Dept.	77	41	0.53	
	Cal-Neva	60	38	0.63	
	Sparks	65	43	0.66	0.61
Reno/ Millipore	Health Dept.	77	51	0.66	
	Cal-Neva	60	33	0.55	
	Sparks	64	32	0.50	0.57

described in Task D/E are applied to mineral emissions, it can be expected that only 60 percent of any reduction in emissions due to the control strategies will be observed in the ambient air quality as measured by the high-volume sampler. Therefore, the weighing factor will be applied as follows:

Percent reduction in fugitive dust emissions
due to application of control strategy

times

weighing factor, 0.60

equals

effective percent reduction in fugitive dust
emissions.

For example, if a given control strategy can reduce emissions by 30 percent, the effective reduction in ambient air quality is 30 x 0.6 = 18 percent. The Hanna-Gifford model, used for the evaluation of control strategies in this study (see Chapter 3, Task D/E), accounts for reduction in emissions and air quality in a one-to-one ratio. Because of this, the true beneficial impact of any control strategy on air quality can be observed only if the effective reduction, rather than the true control strategy reduction, is applied to the emissions. Thus, for this example, emissions from those source categories which are affected by the given control strategy are reduced by 18 percent for evaluation by the model.

This weighing factor of 0.60 is to be applied to control strategy reductions in both Las Vegas and Reno.

6. DATA ANALYSIS

Comparisons of particle size distributions obtained from Andersen cascade filters and microscopic analyses of glass fiber and millipore filters are presented in Figures 6-1, 6-2, and 6-3 for each site for which such data are available. The large discrepancy between the size distributions shown by the Andersen filters and that of the other two filters is due to the marked difference in the sampling principles and analysis methods involved. The size distribution obtained through microscopic analyses of the glass fiber and millipore filters are based on physical size alone, while the size distribution obtained from the Andersen analysis is based on a particle's aerodynamic characteristics dependent on the velocity, density and shape of the particle and the viscosity of the air. Because these methods are so dissimilar the size distributions cannot be compared directly. The size distributions shown by the glass fiber and millipore filters agree quite well. There is, however, a tendency for the glass fiber filters to collect a greater percentage of the larger particles due to the higher flow rate through these filters than through the millipore filters.

Table 6-1 shows the comparison between the microscopic analyses of the glass fiber and millipore filters at selected sites by sampling date. Although noticeable differences may appear on daily samples, the percents by weight collected by each filter type occur within a similar range. The data for the remaining sites are similar to that shown for the two sites illustrated in Table 6-1.

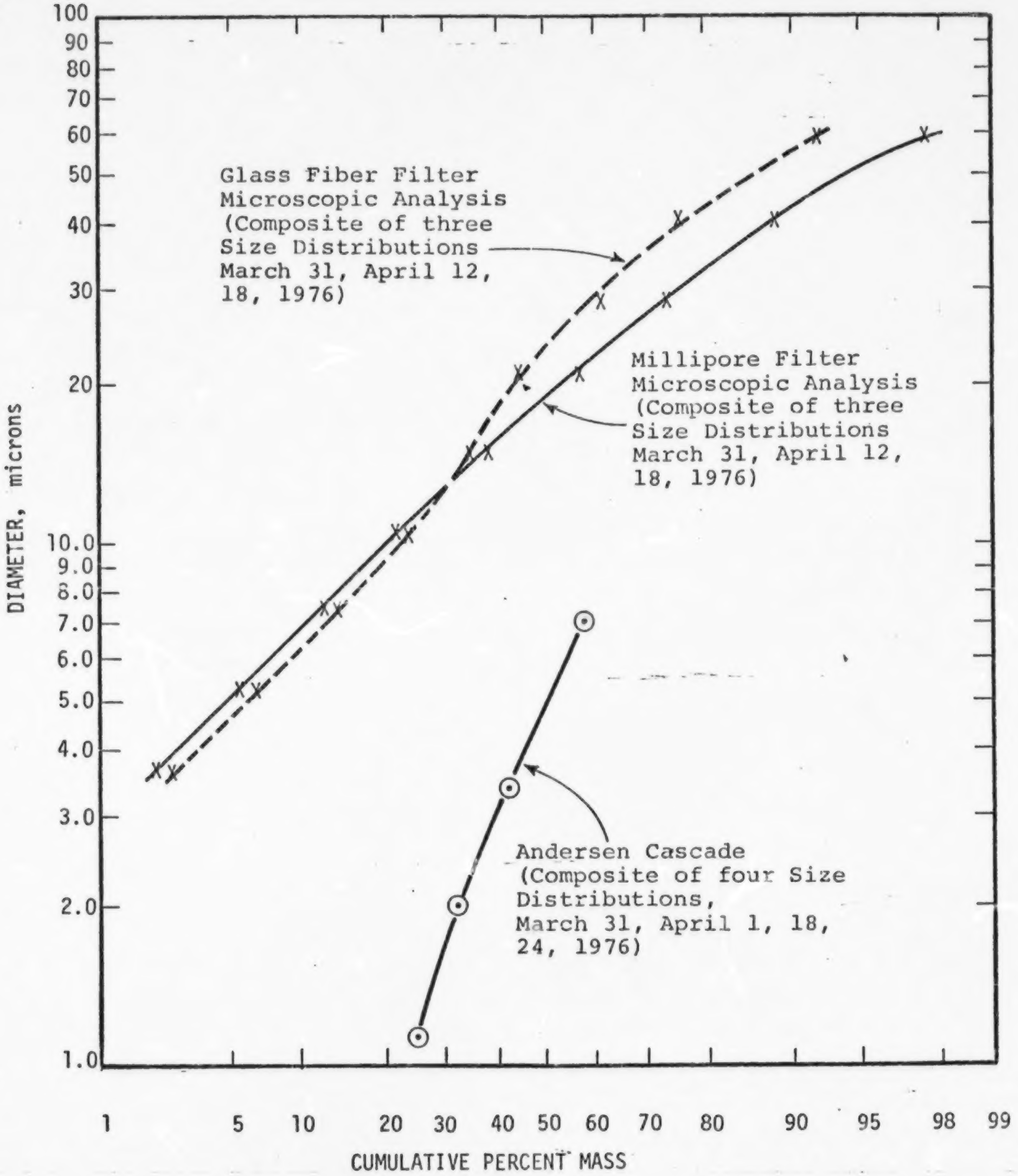


Figure 6-1. Comparison of particle size distributions for Las Vegas site Sunrise Power Plant.

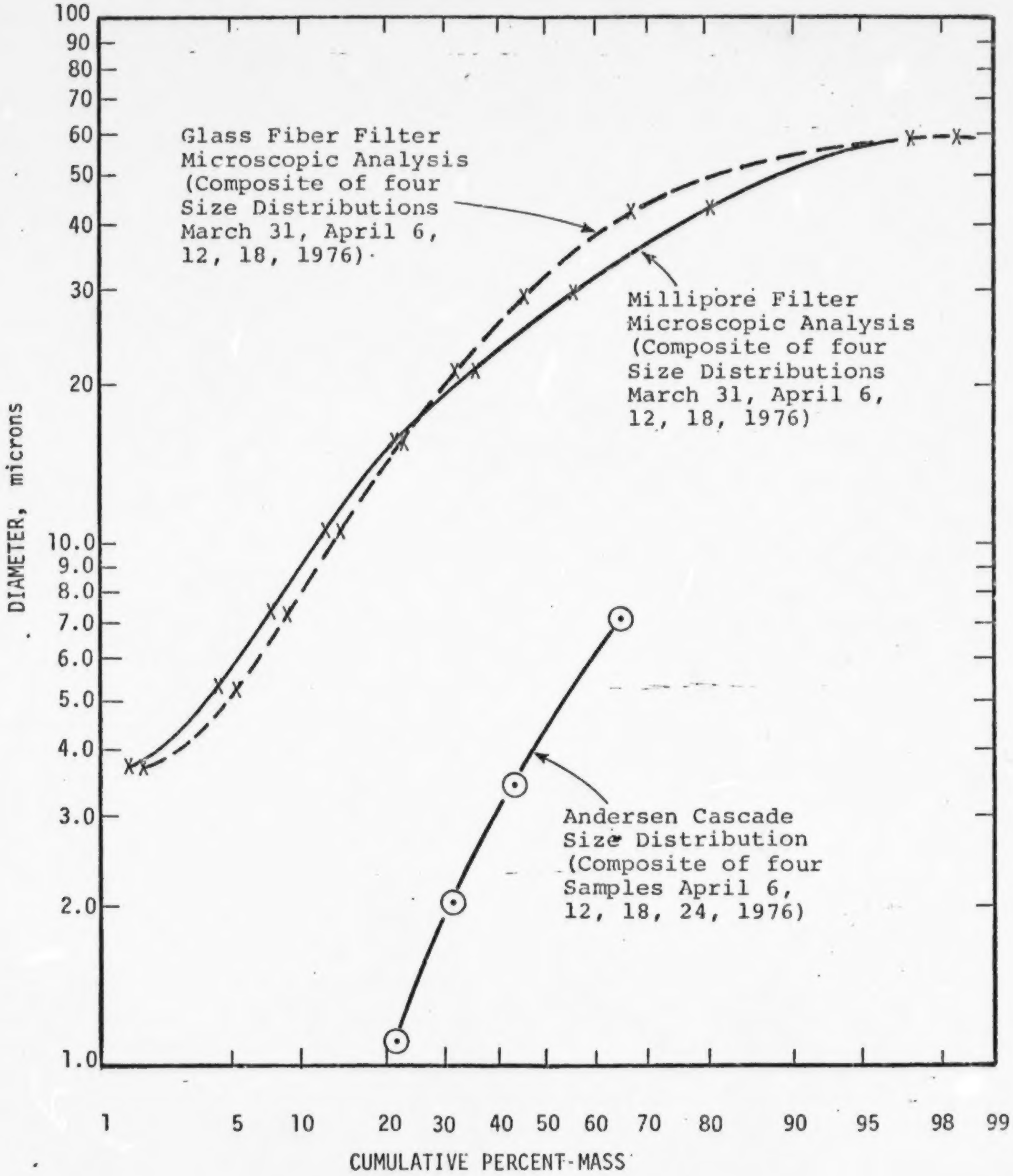


Figure 6-2. Comparison of particle size distributions for Las Vegas site Sahara Hotel.

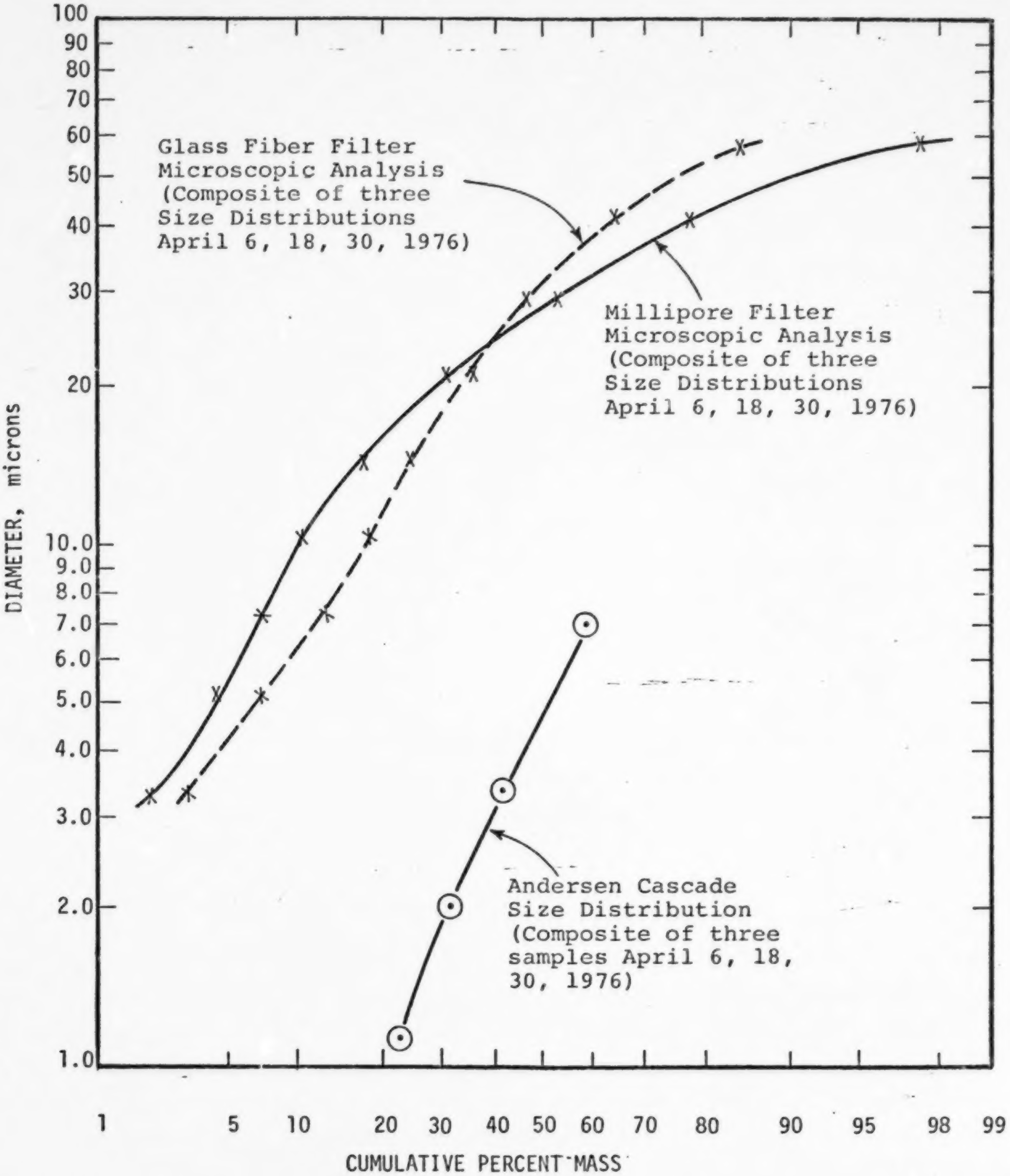


Figure 6-3. Comparison of particle size distributions for Reno site Sparks Nugget.

Table 6-1. COMPARISON OF MICROSCOPIC EVALUATION OF GLASS FIBER AND MILLIPORE FILTER - SELECTED SITES

Site	Date	% by Weight					
		Combustion		Mineral		Tire Abrasion	
		G.F.	M	G.F.	M	G.F.	M
Sahara	3/31	34	63	62	36	3.7	1.0
	4/6	75	57	25	42	0.39	1.2
	4/12	43	56	57	43	0.08	0.46
	4/18	53	53	45	46	1.6	1.8
Sparks-Nugget	4/6	62	71	37	26	1.1	3.0
	4/12	62	57	36	41	2.1	1.7
	4/18	41	54	58	44	1.9	1.4
	4/24	30	64	67	33	3.3	2.7
	4/30	70	79	25	19	4.3	1.8

G.F. = Glass Fiber
M = Millipore

Table 6-2 shows the comparison of correlation coefficients for selected pairs of variables. Inconsistencies in the values of these coefficients are quite apparent. Note that the number of samples used to determine each correlation is extremely low. The correlations by sampling period were compiled for Las Vegas with four samples, and in Reno with five, while the correlations by station were compiled for both areas with only three samples. In order to be within a 95 percent confidence interval, the minimum correlation coefficient which shows that a sample size of 5 is statistically significant is 0.88.[1] Sample sizes of 3 or 4 are significant if the minimum correlations are 0.98 or 0.95, respectively. In any case, it appears that further experimental results are required to identify any real correlations, if they exist.

Table 6-2. TABULATION OF CORRELATION COEFFICIENTS FOR PERTINENT COMBINATIONS OF VARIABLES

(Las Vegas)

Filter type	Variables		Correlation coefficients	
	Particle type (percent by weight)	Chemical analysis/ TSP loading ($\mu g/m^3$)	Sampling period (day)	Station
Glass fiber	Combustible	Pb	-0.03	0.54
Glass fiber	Mineral	Ca	0.97	-0.22
Glass fiber	Combustible	Combustible	0.80	0.98
Glass fiber	Mineral	TSP loading	-0.89	-0.32
Glass fiber	Combustible fraction	TSP loading	0.90	0.32
Millipore	Mineral	Silicates	0.74	0.00
Millipore	Combustion fraction	Pb	-0.09	0.76
Millipore	Mineral	Ca	-0.68	0.59
		(Reno)		
Glass fiber	Combustible	Pb	0.16	0.08
Glass fiber	Combustible	Combustible	-0.43	-0.55
Glass fiber	Mineral	TSP loading	0.05	-0.05
Glass fiber	Combustible fraction	TSP loading	-0.08	0.05
Millipore	Combustible	Pb	0.76	0.98
Millipore	Combustible	Combustible	0.35	1.00

REFERENCES FOR SECTION 6

1. David, F.N. Tables of the Correlation Coefficient, the Biometrika Office, University College, London, 1938.

Table A-1. MICROINVENTORY OF PARTICULATE EMISSIONS AT HENDERSON POST OFFICE SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	8.4 acres	2.16-2.40 ton/ac/yr[a]	19.2		
Unpaved roads	209.5 VMT/day	5.3 lb/VMT	202.6		
Normal paved roads	66,066 VMT/day	1.75 gm/VMT	42.2		
Sand and gravel pits	12.3 acres active	3.4 ton/ac/yr	41.8		
Unpaved parking lots	3.7 acres	0.74 ton/ac/yr	2.7		
Heavy equipment storage	8.0 acres	1.34 ton/ac/yr	10.7		
Stationary area source fuel combustion[b]					6.0
Motor vehicles[c]	66,066 VMT/day	0.0013 lb/VMT		6.4	9.6
Point source			180.0		
Total			499.2	6.4	15.6
Percent of total			96	1	3

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] See summary table in Task C report.

[c] Assume 60 percent of emission are due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table A-2. MICROINVENTORY OF PARTICULATE EMISSIONS AT SAHARA HOTEL SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Active construction	88 acre-months	1.0 ton/ac/mo	92.0[a]		
Cleared areas	179.2 acres	0.44-1.34 ton/ac/yr[b]	142.9		
Unpaved roads	32 VMT/day	5.3 lb/VMT	31.0		
Normal paved roads	273,668 VMT/day	1.75 gm/VMT	174.9		
Unpaved parking lots lots	12,143 VMT/yr plus 4.25 acres	1.8 lb/VMT 0.74 ton/ac/yr	14.0		
R.R. right of ways	4.1 acres	0.9 ton/ac/yr	3.7		
Heavy equipment storage	7.5 acres	1.34 ton/ac/yr	10.1		
Dirty paved roads	28,410 VMT/day	28 gm/VMT	319.7		
Stationary area source fuel combustion[c]					2.0
Motor vehicles[d]	317,946 VMT/day	0.0013 lb/VMT		30.2	45.2
Railroads	51,392 gal/yr	0.025 lb/gal			0.6
Point source			7.0		
Total			795.3	30.2	47.8
Percent of total			92	3	5

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] See summary table in Task C report.

[d] Assume 60 percent of emissions are due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table A-3. MICROINVENTORY OF PARTICULATE EMISSIONS AT SUNRISE POWER PLANT SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	6.1 acres	1.14-1.28 ton/ac/yr[a]	7.4		
Normal paved roads	400 VMT/day	1.75 gm/VMT	0.2		
Sand and gravel pits	19.7 acres active	3.4 ton/ac/yr	68.6		
	1.4 acres inactive	1.4 ton/ac/yr			
Unpaved parking lots	415 VMT/yr	1.8 lb/VMT	0.4		
Agriculture	23 acres	tilling 0.49 ton/ac/yr windblown 0.11 ton/ac/yr	13.8		
Stationary area source fuel combustion[b]					3.4
Motor vehicles	400 VMT/day	0.0013 lb/VMT		Neg.	Neg.
Point source[c]					
Power plant[d]			364		
Total			454.4		3.4
Percent of total			99		1

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] See Summary table in Task C report.

[c] Impact on air quality is reduced 50% due to location, i.e., reported 727 tons x 0.5 = 364 tons.

[d] Emissions omitted from this analysis due to proximity to hi-vol site.

Table A-4. MICROINVENTORY OF PARTICULATE EMISSIONS AT CAL-NEVA CLUB SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	2.6 acres	0.2-0.3 ton/ac/yr[a]	0.7		
Unpaved roads	8.0 VMT/day	3.9 lb/VMT	5.7		
Normal paved roads	452,233 VMT/day	1.75 gm/VMT	255.9		
Unpaved parking lots	1.5 VMT/day	1.6 lb/VMT	0.4		
R.R. right of ways and yards	10.4 acres	0.2 ton/ac/yr	2.0		
Agriculture	16.3 acres	windblown 5.36 lb/ac/yr tilling 280 lb/ac/yr	2.3		
Sand on streets for snow control			22.8		
Stationary area source fuel combustion					52.5
Fireplaces					26.7
Motor vehicles[b]	452,233 VMT/day	0.0013 lb/VMT		42.9	64.4
Railroads	189,690 gal/yr	0.025 lb/gal			2.4
Total			289.8	42.9	146.0
Percent of total			61	9	30

[a] Range of emission factors used. Factors vary soil type, vegetative cover, traffic, and stabilization.

[b] Assume 60 percent of emissions due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table A-5. MICROINVENTORY OF PARTICULATE EMISSIONS AT SPARKS NUGGET SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Active construction	22.4 acre-months	1.0 ton/ac/mo	22.6[a]		
Cleared areas	4.4 acres	0.2-0.24 ton/ac/yr[b]	1.0		
Playground	4.8 acres	1.5 ton/ac/yr	7.2		
Unpaved roads	40 VMT/day	3.9 lb/VMT	28.5		
Normal paved roads	149,083 VMT/day	1.75 gm/VMT	84.4		
Unpaved parking lots	4.5 acres	0.65 ton/ac/yr	3.0		
R.R. right of ways and yards	84.2 acres	0.2 ton/ac/yr	16.8		
Heavy equipment storage	2.2 acres	0.32 ton/ac/yr	0.7		
Dirty paved roads	2,266 VMT/day	28 gm/VMT	20.5		
Stationary area source fuel combustion					25.2
Fireplaces					37.0
Motor vehicles[c]	151,349 VMT/day	0.0013 lb/VMT		14.4	21.5
Railroads	256,266 gal/yr	0.025 lb/gal			3.2
Point source			0.2		
Total			184.9	14.4	86.9
Percent of total			65	5	30

[a] Included are cleared area emissions for time period other than active construction.

[b] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[c] Assume 60 percent of emissions due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).

Table A-6. MICROINVENTORY OF PARTICULATE EMISSIONS AT WASHOE COUNTY HEALTH DEPARTMENT SITE

Source category	Emission level parameter	Emission factor	Particulate emissions, ton/yr		
			Mineral	Tire wear	Combustion
Cleared areas	9.8 acres	0.18-0.82 ton/ac/yr[a]	2.5		
Playground	1.7 acres	1.5 ton/ac/yr	2.6		
Unpaved roads	333 VMT/day	3.1-4.7 lb/VMT[b]	198.8		
Normal paved roads	428,101 VMT/day	1.75 gm/VMT	242.3		
Sand and gravel pits	60.0 acres	1.9 ton/ac/yr	114.0		
Unpaved parking lots	1.9 VMT/day	1.6 lb/VMT	0.6		
R.R. right of ways and yards	10.4 acres	0.2 ton/ac/yr	2.0		
Heavy equipment storage	6.6 acres	0.32 ton/ac/yr	2.1		
Agriculture	16.3 acres	windblown 5.36 lb/ac/yr tilling 280.0 lb/ac/yr	2.4		
Sand on streets for snow control			21.6		
Stationary area source fuel combustion					52.5
Fireplaces					26.7
Motor vehicles[c]	428,101 VMT/day	0.00013 lb/VMT		40.6	61.0
Railroads	187,183 gal/yr	0.025 lb/gal			2.3
Point source			19.0		
Total			607.9	40.6	142.5
Percent of total			77	5	18

[a] Range of emission factors used. Factors vary by soil type, vegetative cover, traffic, and stabilization.

[b] Range of emission factors used. Factors vary by vehicle speed.

[c] Assume 60 percent of emissions due to combustion and 40 percent due to tire wear (Reference 2, Table D.1-21).